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TENTH ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

JANUARY, 1879.

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MEMBERS OF THE BOARD.

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GENERAL REPORT OF THE BOARD.

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, January, 1879.

To the Honorable the Senate and the House of Representatives of Massachusetts.

THE State Board of Health herewith respectfully present their Tenth Annual Report.

THE LAW CONCERNING SLAUGHTER-HOUSES AND NOXIOUS AND OFFENSIVE TRADES.[1]

At the quarterly meeting of the Board held July 5, 1871, a petition was presented, requesting the Board to exercise their

[1] [Chap. 167.]

AN ACT CONCERNING SLAUGHTER-HOUSES AND NOXIOUS AND OFFENSIVE TRADES.

Be it enacted, &c., as follows: —

SECTION 1. Whoever in any city or town [containing more than four thousand inhabitants][1] erects, occupies, or uses any building for carrying on therein the business of slaughtering cattle, sheep, or other animals, or for melting or rendering establishments, or for other noxious or offensive trades and occupations, or permits or allows said trades or occupations to be carried on upon premises owned or occupied by him or them, without first obtaining the written consent and permission of the mayor and aldermen or selectmen of such city or town, shall forfeit a sum not exceeding two hundred dollars for every month he or they so occupy or use such building or premises, and in like proportion for a longer or shorter time: *provided,* that the terms of this section shall not apply to any building or premises now occupied or used for the trades or occupations before described; but no person or persons or corporation now occupying or using any building or premises for the trades or occupations aforesaid, shall enlarge or extend the same without first obtaining the written consent and permission of the mayor and aldermen or selectmen of the city or town in which such building or premises are situated, in the manner provided in this section.

SECT. 2. Whenever in any city or town [containing more than four thousand inhabitants][1] any building or premises are occupied or used by any person or persons or corporation for carrying on the business of slaughtering cattle, sheep, or other animals, or for melting or rendering establishments, or for other noxious or offensive trades, the State Board of Health may, if in their judgment the public health or the public comfort and convenience shall

[1] Stricken out by chap. 308, acts of 1874.

powers under the Act of April 8, 1871, in suppressing an alleged nuisance on premises occupied by Mr. George A. Sawyer, in Watertown. The hearing required by statute was held July 19; and July 26, the order was adopted, that the defendant be directed:—

1st, To make a complete floor of hydraulic cement, impervious to blood and to water, in the basement of his slaughter-house, where the offal and blood are now [1871] received in carts.

2d, To construct a drain by which the water used for washing both the slaughtering-floor and the basement-floor shall be conveyed to a point at least one hundred and fifty feet from any dwelling.

3d, To so change the construction of the carts used for removing offal and blood, that they shall have complete metallic linings, and that the necessary openings be fitted so that leakage shall be impossible.

4th, That the heads and feet and all other parts of slaughtered animals be securely protected against dogs, as well as against all other means by which animal matters may become scattered about the neighborhood.

5th, That, immediately after a day's work is finished, the slaughtering-floor be scraped, or strewn with chloride of lime.

The above order was never obeyed; and it was later the opinion of the Board, supported by eminent legal advice, that the statute did not allow regulation of noxious and offensive trades by the State Board of Health, but only orders to cease and desist, or to continue. This, however, amounted to regulation in most cases, as certain stipulations were proposed, after a hearing; and upon refusal to comply,

require, order any person or persons or corporation carrying on said trades or occupations to desist and cease from further carrying on said trades or occupations in such building or premises; and any person or persons or corporation continuing to occupy or use such building or premises for carrying on said trades or occupations after being ordered to desist and cease therefrom by said board, shall forfeit a sum not exceeding two hundred dollars for every month he or they continue to occupy and use such building or premises for carrying on said trades or occupations after being ordered to desist and cease therefrom by said board as aforesaid, and in like proportion for a longer or shorter time: *provided*, that on any application to said board to exercise the powers in this section conferred upon them, a time and place for hearing the parties shall be assigned by said board, and due notice thereof given to the party against whom the application is made, and the order hereinbefore provided shall only be issued after such notice and hearing.

SECT. 3. The supreme judicial court or any one of the justices thereof, in term time or vacation, shall have power to issue an injunction to prevent the erection, occupancy, use, enlargement or extension of any building or premises occupied or used for the trades or occupations aforesaid, without the written consent and permission provided in section one of this act being first obtained: and also in like manner to enforce the orders of the State Board of Health issued under section two of this act.

[*Approved April 8, 1871.*]

or upon compliance, with the directions given, the corresponding order was issued.

Jan. 24, 1876, the selectmen of Watertown requested the Board to enforce against Mr. Sawyer the provisions of the 167th chapter of the Laws of 1871, with regard to slaughter-houses and noxious and offensive trades, as he had failed to comply with the orders passed as above, in 1871. It was decided that it would be necessary to have another hearing, which was held March 18, postponed from March 11, the day first appointed. As the defendant declined to render his place free from offence and reasonable cause of complaint, he was, on April 14, served with an order to cease and desist from his business May 15, 1876.

The case was appealed to the Superior Court, who decided that they had no jurisdiction under the law, when it was carried to the Supreme Court for their opinion. The Court decided, that, although there was no right of appeal from the orders of the Board of Health expressed in the law, yet that such was its intent, as otherwise the statute would be unconstitutional. The decision is given in full, as follows: —

COMMONWEALTH OF MASSACHUSETTS.

MIDDLESEX, ss.

SUPREME JUDICIAL COURT, JANUARY LAW TERM, 1877.

GEORGE A. SAWYER *vs.* STATE BOARD OF HEALTH.

OPINION OF THE COURT.

LORD, J. — The only question which has been submitted for our determination in this case is: Has the petitioner, under the statutes of this Commonwealth, a right to a trial by jury upon the question whether the exercise of his business is dangerous to the public health? It is contended by the petitioner, that if the statute of 1871, chap. 167, applies to his building and trade, and deprives him of the right of appeal to a jury, it is unconstitutional. The respondent, on the other hand, contends that the statute is simply a license law, and can be sustained as a license law, even to the extent of preventing the petitioner from carrying on his business within the constitutional exercise of legislative authority, although he has no right of trial by jury.

The important question at the outset, therefore, is, did the Legislature intend that the order of the State Board of Health passed under § 2, requiring the petitioner "to cease and desist from carrying on the said business on the said premises on and after the fifteenth day of May, 1876," should be absolute, final, and irrevocable?

This statute is to be expounded in view of all existing laws upon the same subject matter, and is, if consistent with proper rules of construction and interpretation, to be so construed as to be in harmony with the provisions of the Constitution of the Commonwealth. If, however, by reasonable construction, the statute cannot be interpreted in such manner as to be consistent with the Constitution, the Constitution must prevail, and the statute is void. It is necessary therefore to examine the legislation upon this subject.

The earliest provincial act upon the subject of slaughter-houses is that of 1692-3 (4 W. and M.), *c.* 23, which is as follows: —

"The selectmen of the towns of Boston, Salem, and Charlestown, respectively, or other market towns in the province, with two or more justices of the peace dwelling in the town, or two of the next justices in the county, shall, at or before the last day of March, 1693, assign some certain places in each of said towns (where it may be least offensive) for the erecting or setting up of slaughter-houses for the killing of all meat, still-houses, and houses for trying of tallow and currying of leather (which houses may be erected of timber, the law referring to building with brick or stone notwithstanding), and shall cause an entry to be made in the town-book of what places shall be by them so assigned, and make known the same by posting it up in some public places of the town; at which houses and places, respectively, and no other, all butchers and slaughter-men, distillers, chandlers, and curriers shall exercise and practise their respective trades and mysteries: on pain," &c. 1 Prov. Laws (State ed.) 59.

In passing, we may refer, as bearing upon the question whether the legislation on this subject has been in the nature of license laws, to the Prov. St. of 1692-3 (4 W. and M.), *c.* 20, § 1, in reference to the sale of intoxicating liquors, in these words: "No person or persons whatsoever (other than such as, upon producing certificate from the selectmen of the town where they dwell, or who shall be otherwise thought fit by the justices themselves, shall be licensed by the said justices in quarter sessions) may presume to be a common victualler, innholder, taverner, or seller of wine, beer, cider, or strong liquors by retail, nor shall any presume, without such license, to sell wine or strong liquors privately, by a less quantity than a quarter cask, and that delivered and carried away all at one time, on pain of forfeiting," &c. 1 Prov. Laws, 56. And similar license laws have been enacted at various times, from that time to the present. There are other provisions to which it is not necessary to refer. The St. of 1692-3 made no provision for prohibiting the business of slaughtering, &c., in places which had been once assigned for that purpose.

By the St. of 1710-11 (9 Anne), *c.* 8, provision is made upon that subject. The preamble of the act is substantially a recitation of the act before quoted, and the first section is a concise re-enactment of the same provisions. The second section is as follows: —

"When and so often, from time to time, as it shall appear any house or place assigned or to be assigned to and for the exercising of either of the aforesaid trades or mysteries, to become a nuisance by reason of offensive and ill stenches proceeding from the same, or otherwise hurtful

to the neighborhood, it shall and may be lawful to and for the court of general sessions of the peace within the county, to cause inquiry to be made thereinto by a jury, and to suppress such nuisance by prohibiting and restraining the further use thereof for the exercise of either of the aforesaid trades or mysteries under a fine," &c. 1 Prov. Laws, 656. From that time till 1871 various changes and re-enactments of the law took place; and in every instance, so far as we know, provision was incorporated into the law, by which the question, whether a place which had been once lawfully established for the exercising such trades should be discontinued by public authority, was ultimately to be determined by a jury. The learned counsel for the respondent in their extremely able and thorough argument have failed to call our attention to any legislative act vesting the ultimate power of decision in any other tribunal.

Article 15 of the Declaration of Rights is as follows: "In all controversies concerning property, and in all suits between two or more persons, except in cases in which it has heretofore been otherways used and practised, the parties have a right to a trial by jury; and this method of procedure shall be held sacred, unless in causes arising on the high seas, and such as relates to mariners' wages, the legislature shall hereafter find it necessary to alter it."

These citations are made not for the purpose of showing that the legislative act in question is in violation of the Constitution and therefore void, but, as before intimated, for the purpose of grouping the legislation as it existed at the time of passing the act in order to aid us in the interpretation of it. And in the same view, it becomes necessary to look into existing laws.

By the Gen. Sts. *c.* 26, the whole power of regulation of noxious and offensive trades is committed to the respective boards of health of the several towns. They may assign places for the exercise of such trades, and may revoke such assignments (§ 52). The rights of the public, and of the individual exercising the trade, are carefully secured. If the town board of health refuses to revoke an assignment, after the place shall have become a nuisance, and perhaps without any effort to procure a revocation, any person aggrieved may apply to the Superior Court for a revocation of the assignment, and the court may after a trial revoke the same (§ 53). If the board revokes the assignment, any person aggrieved by the revocation may have an appeal to a jury, who may annul the revocation (§§ 55, 56). The rights of the public are fully secured. Whenever by public authority the assignment is revoked, that revocation is effectual and in force, until the decision is annulled by verdict of a jury (§ 57). These provisions of law were all in full force when the St. of 1871 was passed.

It now becomes important to examine the statutes in relation to the State Board of Health. That Board was established by the St. of 1869, *c.* 420. The Board was to "take cognizance of the interests of life and health among the citizens of the Commonwealth." They were to "make sanitary investigations and inquiries in respect to the people, the causes of disease, and especially of epidemics and the sources of mortality, and the effects of localities, employments, conditions, and

circumstances, on the public health;" and "gather such information in respect to those matters as they may deem proper for diffusion among the people." It was also their duty to "advise the government in regard to the location of any public institutions." They are required also to report to the legislature "their doings, investigations, and discoveries during the year ending December thirty-first, with such suggestions as to legislative action as they may deem necessary."

It is made their duty also "to examine into and report what, in their best judgment, is the effect of the use of intoxicating liquor as a beverage upon the industry, prosperity, happiness, health, and lives of the citizens of the State. Also what additional legislation, if any, is necessary in the premises." This is the whole duty of the Board under the act establishing it. No other power or duty was conferred or imposed upon such board until the St. of 1871, *c.* 167, which is the act under consideration. The first section of that act provides: "Whoever, in any city or town containing more than four thousand inhabitants, erects, occupies, or uses any building, for carrying on therein the business of slaughtering cattle, sheep, or other animals, or for melting or rendering establishments, or for other noxious or offensive trades and occupations, or permits or allows said trades or occupations to be carried on upon premises owned or occupied by him or them, without first obtaining the written consent and permission of the mayor and aldermen or selectmen of such city or town, shall forfeit a sum not exceeding two hundred dollars for every month he or they so occupy or use such building or premises, and in like proportion for a longer or shorter time: *provided*, that the terms of this section shall not apply to any building or premises now occupied or used for the trades or occupations before described." It is agreed that the petitioner's premises are within the proviso, and might be used without such permission.

It will be observed also that the use is not authorized by that act, but simply that the terms of the act shall not apply to buildings then actually in use. If therefore the language of the section could be construed as a license, it is not easy to see how it can be a license of that which is in terms excluded from its operation. The precise question to be determined in this case arises under the second section of the act of 1871, which is as follows: "Whenever, in any city or town containing more than four thousand inhabitants, any building or premises are occupied or used by any person or persons or corporation for carrying on the business of slaughtering cattle, sheep, or other animals, or for melting or rendering establishments, or for other noxious or offensive trades, the State Board of Health may, if in their judgment the public health or the public comfort and convenience shall require, order any person or persons or corporation carrying on said trades or occupations to desist and cease from further carrying on said trades or occupations in such building or premises; and any person or persons or corporation continuing to occupy or use such building or premises for carrying on said trades or occupations, after being ordered to desist and cease therefrom by said Board, shall forfeit a sum not exceeding two hundred dollars for every month he or they continue to occupy and use such building or premises

for carrying on said trades or occupations after being ordered to desist and cease therefrom by said Board as aforesaid, and in like proportion for a longer or shorter time: *provided*, that on any application to said Board to exercise the powers in this section conferred upon them, a time and place for hearing the parties shall be assigned by said Board, and due notice thereof given to the party against whom the application is made: and the order hereinbefore provided shall only be issued after such notice and hearing."

This section authorizes the State Board of Health to forbid the exercise of the offensive trade in any municipality of more than four thousand inhabitants. This is its whole power, under that or any other provision of law in respect to the regulation of noxious trades. By the first section of the act, the Legislature have declared their purpose that the general subject of noxious and offensive trades shall be within the control of the boards of health of the municipal corporations. Precisely the same power is given by the Gen. Sts., *c*. 26, § 52, to the boards of health of towns, as by this section is given to the State Board of Health. The only difference is this, that by the statute of 1871 the State Board of Health is bound to give notice to a party to allow him a hearing before it can pass an order of prohibition; but under the Gen. Sts., *c*. 26, § 52, the selectmen may pass an order of prohibition without any previous notice. *Belcher* v. *Farrar*, 8 Allen, 325.

We cannot suppose that the Legislature intended to change the whole system of regulation of noxious trades by simply conferring the power to prohibit in certain cases upon the State Board of Health.

If the construction contended for by the respondent is correct, there is nowhere any power of revision of the action of the Board. It is absolute, final, conclusive. In cities and towns containing four thousand inhabitants, the whole system, so elaborately prepared and enacted by the Gen. Sts., *c*. 26, by which the rights of the public and the rights of citizens are secured through the intervention of trials by jury in the county and before the Superior Court, is absorbed in the jurisdiction of a State Board of Health; and this, too, without a suggestion of the repeal of the many provisions of the existing laws which are in conflict with this construction, and with the strong intimation conveyed by the first section, that the general system is to be preserved. It is not necessary to look at the consequences of such an interpretation, to induce us to reject it; still those consequences are proper subjects for consideration, and are presumed to have been seen by the Legislature. It is undoubtedly true that the mayor and aldermen or selectmen may authorize, in writing, the carrying on of noxious and offensive trades at a certain place in a city or town of more than four thousand inhabitants; and the day after the occupancy commences, the State Board of Health may give a notice and hearing to the party thus authorized, and may issue an order forbidding the use of that place.

Did the Legislature intend that the town board of health might then again authorize the same business in the same place, to be again prohibited by the State Board of Health? We can no more suppose that the Legislature intended to introduce this conflict and confusion into the

law, than that it intended, by implication, to submit the whole system of regulation by absorption into a general authority of prohibition, all over the Commonwealth, by a board composed of only seven members, serving without compensation, and necessarily strangers to the great majority of the various municipalities, and unacquainted with their local interests.

The only construction which we can give to the statute, consistent with the Constitution of the Commonwealth, with existing laws recognized by the Act itself as still in force, with the general policy of the legislation upon the subject, is to treat the power given by the statute as given subject to the same limitations and qualifications as that given to town boards of health upon the same subject, and of course with the same right of appeal. This construction of the statute preserves the general system provided by law unimpaired; it simply gives to the State Board of Health jurisdiction (whether concurrent with the town boards, or exclusive, it is not material to this case to inquire), in cities and large towns to do what may be done in every town of the Commonwealth by the local board of health; but we do not think that it was the purpose of the Legislature, nor does the language of the Act compel us to say that its effect is, to deprive the party of that right of trial by jury to which the citizens in such cases have been accustomed for nearly two centuries. By the Gen. Sts., *c.* 26, § 52, "the board" (the town board of health) "may also forbid the exercise of such trade or employment within the limits of the town or in any particular locality thereof." By § 55, the "orders of prohibition under § 52 shall be served upon the occupant or person having charge of the premises where such trade or employment is exercised." By § 56, "any person aggrieved by such order may appeal therefrom," &c. Although the whole proceeding is statutory, and not according to the rules of the common law, we think it was the purpose and intention of the Legislature that the decision of the new tribunal should be subject to the same rights of appeal as that of the local board. Many questions present themselves which have not been discussed, which the parties, if they desire, may raise upon the trial, and to which it is not necessary to refer. The result of our whole consideration is that the Superior Court erred in dismissing the petition, and that it must *Stand for further hearing.*

The verdict in the Superior Court allowed the defendant to continue his business, provided he carried it on with improvements essentially the same as those already required by the State Board of Health in 1871, and also in a manner satisfactory to the local Board of Health. The finding of the jury was: —

The jury alter the order of the State Board of Health as dated April 5, 1876, as follows: That Mr. George A. Sawyer shall be permitted to continue the business of slaughtering animals on the premises now

occupied by him, in the town of Watertown, under the following restrictions: —

1. Mr. George A. Sawyer shall be required to concrete the cellar under his slaughter-house, in concave form.

2. Mr. Sawyer shall not keep swine in or under his slaughter-house.

3. All offal and offensive matter shall be removed from the above premises before ten o'clock, P.M., of the day of killing, in covered, water-tight boxes or tanks.

4. Said premises shall be kept at all times in a condition of neatness and cleanliness acceptable to the local board of health.

The Supreme Court decided upon this verdict, as follows: —

COMMONWEALTH OF MASSACHUSETTS.

MIDDLESEX, ss.

SUPREME JUDICIAL COURT, JANUARY LAW TERM, 1878.

GEORGE A. SAWYER vs. STATE BOARD OF HEALTH.

OPINION OF THE COURT.

LORD, J. — When this petition was before us at a former term, it was decided that the petitioner had the same right of appeal from an order of the State Board of Health as from that of the local board.

The Statutes of the Commonwealth do not in terms authorize either the local or State Board of Health to prescribe regulations for the mode of carrying on noxious or harmful trades or business. Their power is that of prohibition. (Gen. Sts., *c.* 26, § 52.) Although no authority is given to regulate "offensive trades," yet by § 5 of the same chapter it is provided that "the Board shall make such regulations as it judges necessary for the public health and safety respecting nuisances, sources of filth, and causes of sickness within its town," &c.

By sect. 56 any person aggrieved by the order of prohibition may appeal therefrom, and provision is made for a speedy hearing before a jury.

Sect. 58 provides that the verdict of the jury, which may either alter the order, or affirm or annul it in full, shall be returned to the Court for acceptance as in the case of highways; and said verdict when accepted shall have the authority and effect of an original order from which no appeal had been taken.

In view of these provisions of the statute, we do not deem it necessary to determine the question whether the power of prohibition includes that of regulation; for we think, taking all the legislation upon the subject in view, that the statute confers upon the boards of health the power to regulate the mode in which "offensive trades" shall be carried on. The order of the State Board of Health appealed from is "that George A. Sawyer of Watertown be, and he hereby is, directed to discontinue the business of slaughtering and rendering on the premises now occupied by him, on and after the fifteenth day of May, 1876." It is to

be observed that the business of "slaughtering" and the business of "rendering" are not the same business. They are carried on sometimes conjunctively and sometimes separately. They are not equally offensive, and when carried on in the same establishment they are undoubtedly more offensive than when either is carried on without the other; and whether the prohibition of the State Board of Health is confined to the carrying of both kinds of business in connection, or whether it is an order prohibiting each, is unimportant.

No criticism of the order is made in this respect. The petitioner accepts it as a prohibition of each business; and that is as favorable a view as can be taken for the validity of the order. Nor does the petitioner claim to carry on the business of rendering, nor does he seek for any modification of the order in this respect. His appeal relates only to the order forbidding his carrying on the business of slaughtering.

That subject only was presented to the consideration of the jury. Under the statute above cited, the jury has no authority to affirm the order in full.

Although with slight informality, yet with no possibility of error, the jury find that they do not affirm the order in full. The same section of the statute provides that the jury may alter the order; and upon this branch of the case the jury make "special findings," commencing their special findings thus: "The jury alter the order of the State Board of Health dated April 3, 1870, as follows: that Mr. George A. Sawyer shall be permitted to continue the business of slaughtering animals on the premises now occupied by him in the town of Watertown, under the restrictions as per appended sheet." The restrictions, four in number, as well as the general finding that the order is not affirmed, are signed by the foreman of the jury; and both appear to have been affirmed in court. It would undoubtedly have been within the power of the court, before the verdict was affirmed, to have had all the findings of the jury incorporated into a single one in the form of an order, substantially framed as if ordered by the State Board of Health; and that perhaps would have been the preferable mode of affirming the verdict.

We do not, however, think the mode adopted so defective in form as to require us therefor to set it aside. The record shows that the petitioner set forth in his petition the order of the State Board of Health in the terms in which it was made, and prayed that a jury might either alter or annul in full such order of prohibition.

The several findings of the jury appear also upon the record; and, upon the principle that that is certain which can be made certain, we think the second findings of the jury may be so applied to and incorporated with the original order, that the whole is sufficiently clear, precise and definite, in matter and form.

There remains, then, only the question whether in substance the findings of the jury are warranted; and it seems to us, the proper test of this is, Is the order, as modified by the jury, one which the State Board of Health is authorized to make? and we think it is. As already suggested, we think either the local or the State Board of Health, under the general authority given them to "make such regulations as it judges

necessary for the public health and safety, respecting nuisances, sources of filth," &c., may properly make regulations as to the mode of conducting offensive trades. It may be that such regulations must be enforced, if not obeyed, by absolute prohibition; and it may be that the order making them would of itself be an order of prohibition to the conducting of them in any other mode. The law prescribes no standard by which the propriety of such regulations must be judged. It rests only in the sound judgment and discretion of public officers appointed on account of their qualifications for such duty, but subject to the reversion of a jury; and the restrictions and limitations imposed by a jury must be of an extraordinary character for the Court to interpose, and say that in law they are not authorized. On examining these limitations we cannot see that they are subject to objection.

The first is that "the petitioner shall be required to concrete the cellar under the slaughter-house, in concave form." There can be no doubt or misunderstanding of the meaning of this language, and the court could not say that it is not a proper and reasonable requirement. The second is, "Mr. Sawyer shall not keep swine in or under his slaughter-house." Certainly no objection can be made to this. The third is, "All offal and offensive matter shall be removed from the above premises before ten o'clock P.M. of the day of killing, in covered water-tight boxes or tanks." Nor is there in this any thing objectionable. Of course, the true construction of removal is effectual removal from the premises. The fourth and only remaining restriction is "that said premises shall be kept at all times in a condition of neatness and cleanliness acceptable to the local board of health." We do not understand this finding as an imposition of any duty upon the local board of health. There is probably nothing in it which would not be applied by law if it were omitted. It is a simple declaration that there shall not be allowed any accumulation of filth from any source, or by any means by which the premises should become a nuisance; and the reference to the local board of health is probably as to the legal standard of neatness. But, whatever may be its construction, we do not see that it in any manner vitiates the finding of the jury; for if, when the petitioner has complied with all the regulations of the order as altered by the jury, he by some extraneous means accumulates filth upon his premises, in such manner as to injuriously affect the public health, and in some other mode creates a nuisance, the law would subject him to the control of the local board of health, as well as to that of the State Board.

There is a peculiarity in this proceeding which quite distinguishes it from the ordinary rules which govern appeals. The appeal to a jury does not vacate the order. It remains in full force till annulled or altered. If not annulled or altered, it still stands: if altered, it stands as altered. If the alterations made are absolutely impracticable, the order still stands just as if the original order had been made in the terms of the order as altered by the jury; and, if the original order had contained the same regulations, we certainly could not say, as matter of law, that the order was void. At any rate, we could not say that it was void so far as the restrictions which it was competent for the board of health

to make were concerned, whatever may be said as to any restrictions which it was not within their power to make; and whatever the board of health may do, the jury may do, and with the same effect.

Judgment affirmed.

On the question of damages, the verdict of the jury was that the defendant was not entitled to any thing; and that decision has been carried up to the Supreme Court, for their adjudication.

Although these two opinions do not coincide with the interpretation of the law which the Board had previously held, in accordance with their own views and the opinions of eminent legal counsel, the Board deem it of great importance that the Supreme Court has decided upon the precise nature of the powers granted by the legislature; and the decisions do not affect the future efficiency of the Board. The verdict of the jury in this particular case differs in no essential point from the position which had been taken by the State Board of Health, in 1871.

The case of *Complainants vs. the Bradley Fertilizer Company* still remains undecided by the Board. Certain improvements have been made, which, so far as it has been possible to ascertain, have removed, during the past summer at least, evils to which objections were made, — excepting, however, an alleged accident, which gave rise to foul odors and complaint for a short time in Hingham. It remains to be seen, whether the better methods of conducting the business are sufficient, and of permanent value.

Several petitions, during the summer, were referred to local boards of health; and the Board have had several conferences with the very efficient board of health of Somerville, with reference to abating nuisances in that city.

At a meeting held Dec. 10, 1878, a petition was read to the Board from the Mayor, in behalf of the citizens of Cambridge, complaining that a slaughtering and rendering establishment had been recently erected in Belmont by the Messrs. Niles, within seven hundred feet of Fresh Pond, the water-supply of the city of Cambridge; that the building thus occupied is a public nuisance; and that the public health,

comfort, and convenience, and particularly the health of all persons who use the waters of said Fresh Pond, absolutely require that the said building should not be used for any such purpose. The Board were requested to pass the order requiring Messrs. Niles Brothers to "cease and desist."

The hearings in the case were held Dec. 20, 21, 23, and 27, when a remonstrance was read, stating that the matter was not then within the jurisdiction of the State Board of Health, but wholly cognizable by the selectmen of the town of Belmont, acting as a board of health. The defendants had also received, from the selectmen of Belmont, a license to put up their buildings, and carry on their business; but "not to create a nuisance, or corrupt the waters of Fresh Pond."

The evidence, and other matters of importance in the case, are given fully at a later page in the report for this year. No decision has yet been returned. In justice to both parties, the case still requires investigation. The pollution of the water-supply of a large city must, of course, not be allowed; and the Board must necessarily supervise the establishment with some care, in order to be sure whether further interference is called for, or if so, to what extent.

In the last few reports of the Board, reference has been made to those establishments for carrying on noxious and offensive trades, which had not adopted the proper appliances for avoiding offensive odors, and which were therefore still serious nuisances, not only in the cities where they are placed, but also, at times, in Boston. So far as Somerville is concerned, some of these have been abated, and the others regulated by the local board of health; so that the communities of that city and of Boston, with proper supervision, will be relieved of that portion of what has been for a long time a great evil.

Others still exist, however, in Boston and its immediate vicinity, from which the most nauseating odors are occasionally observed, even to awakening people from sleep; while less marked stinks are frequently noticed. The experience of other works shows that such offensive smells may be avoided. This, however, is a matter over which the State Board of Health have no control, until a formal petition for abatement has been sent to them.

The Disposal of Sewage.

That sewage irrigation is practicable in our climate, has been clearly shown at the Worcester Lunatic Hospital, where it has been demonstrated that the refuse of that large establishment can be disposed of without polluting any body of water. It is very important, however, that the plans of the medical superintendent should be carried out for perfecting the final distribution of the sewage over a larger surface of ground and more uniformly, before an entirely satisfactory solution of the question can be said to have been reached. That will probably be done early in the coming spring, before any serious offence or injury comes from the present method, which consists in allowing all the sewage, except the portion absorbed through the sides and bottom of the main trench, to soak into a large bed of gravel during the summer. The winter arrangement of fertilizing the lawn is thoroughly unobjectionable from every point of view, and works admirably.

At the Danvers Asylum, the disposition of the sewage underground, by means of drainage-pipes, has not been an entire success, so that it will be necessary to make some changes, as suggested by the medical superintendent.

The sewage from the Concord Prison may easily be, and should be, used to fertilize the sand-bank in the immediate vicinity and belonging to the State. An appropriation of $2,500 has been asked for to serve that purpose; and certainly some inexpensive means should be put into requisition to purify the Assabet River, at least during the summer months.

At the Prison for Women in Sherborn, the temporizing measures used to secure at least partial relief from an immediate danger to the Boston water-supply have proved, as was suggested by the Board to the legislative committee of last year and to the original commissioners, entirely inadequate to wholly relieve the difficulty. At the present time, the health of the inmates is seriously jeopardized by the nauseating odors and unwholesome effluvia from the sewage, during the warmer months; and the Boston water supply is endangered

contrary to law. The only practicable remedy consists in the purchase of sufficient land for the proper treatment of the sewage.

There is nothing especially new to report with regard to experience during the past year in reference to the general question of the disposal of sewage. In Great Britain, no greater success has been obtained in making irrigation profitable, and precipitation can only be recommended when other means fail. One hundred and twenty million gallons of sewage discharged into the Thames, respectively ten and fourteen miles below Westminster, thirty miles from the sea, and where the stream is only a half-mile wide, have been reported by the Thames Conservancy engineers to be silting up the river, but the statement is denied flatly by the Metropolitan Board of Works. Both parties support their assertions with references to soundings and chemical examinations, while it is clear that there is no manifest evil or nuisance of any kind. The river does not appear unsightly, and fish have returned to the vicinity of London Bridge, which had not been previously caught there for many years. The old plan has been revived, to reclaim the Essex sands near the mouth of the Thames, and to irrigate them with all the sewage of London, but the enormous cost of the undertaking, and the very slight inconvenience from the present method, appear to stand in the way of its accomplishment.

The intermittent downward filtration system, already referred to in previous reports to the legislature, promises so much, where little land is available, that Kendal was visited, during the past summer, by the secretary of the Board, for the purpose of examining it in detail.

The population of the town in August, 1878, was estimated to be fourteen thousand in round numbers, of whom ten thousand were thought to connect with the sewers, the water-supply being four hundred thousand gallons daily. The average dry-weather flow of sewage is, in round numbers, one million gallons daily, so much diluted with the subsoil drainage which leaks through the sewers as to be of the same strength as London sewage diluted with about twice its bulk of water. The main sewer can discharge only two

million gallons in twenty-four hours, below the storm overflow, so that any excess over that quantity passes directly into the river. This immense amount of sewage is distributed over five acres and a half of land (4a. 2r. 25p. excluding roads, conduits, &c.), by the intermittent downward filtration system, for three hundred and thirty-five days in the year, and flows to a grass-plat of ten acres and a half during the remaining thirty days. The filtration area lies in a very deep bed of gravel, which has been used successfully for five seasons, although better crops might be raised with less sewage. It is interesting to find that the effluent water from the deep drains is entirely clear, although not pure enough to be safe for drinking, and that the soil has not been polluted to an extent which would be injurious away from water-supplies, as shown by Mr. Rogers Field in a series of samples analyzed by Dr. A. Dupré. One hundred parts, calculated dry, contained the quantities of organic and oxidized organic matter indicated in the following table: —

	Unsewaged Surface Soil.	Sludge on top of Soil in Filter Bed.	Soil one inch thick just below sludge.	Soil one inch thick from a depth of six inches.	Soil one inch thick from a depth of one foot.	Soil one inch thick from a depth of two feet.
Ammonia . . .	0.0026	0.0314	0.0043	0.0039	0.0010	0.0008
Nitric Acid . . .	0.0077	0.0098	0.0076	0.0115	0.0157	0.0112
Organic Nitrogen .	0.1178	0.2124	0.1983	0.0715	0.0460	0.0438
Total Nitrogen . .	0.1218	0.2415	0.2046	0.0785	0.0520	0.0482
Organic Matter . .	6.81	8.58	5.56	5.50	3.09	2.68
Phosphoric Acid .	0.0214	0.0344	0.0268	0.0214	0.0166	0.041

The sewerage of Berlin is making rapid progress, and the sewage is all to be disposed of by irrigation. Between nine hundred and ten hundred acres were irrigated with the sewage of Paris in 1877; the quantity of land so treated having increased rapidly each year since the first of the experiment, 1869. A plan is before the authorities for completely removing the filth of Paris from the Seine by the same means.

In all parts of the world, the matter of disposal of sewage is considered one of the most vital questions to be solved in the introduction of sewerage. Indeed, already in England and Germany, no new sewers can be constructed until they

have fulfilled the most stringent requirements of the government in that particular.

Sewerage works are very much needed in many of the cities and towns of our State, but should be undertaken only after the most mature consideration, and after having been approved by a competent authority.

The Pollution of Streams.

The Board have, at present, no additional recommendations to make with reference to the contamination of water-courses and ponds, further than those which have already been published in previous reports. No cases have been brought formally before the Board under the provisions of the following act, relative to the pollution of rivers, streams, and ponds used as sources of water-supply; being chap. 183, of the Acts of 1878: —

Section 1. No person or persons, or corporation, public or private, shall discharge directly, or cause to be discharged directly, human excrement into any pond in this Commonwealth used as a source of water-supply by any city or town therein, or upon whose banks any filter-basin so used is situated, or into any river or stream so used, or upon whose banks such filter-basin is situated, within twenty miles above the point where such supply is taken, or into any feeders of such pond, river, or stream within such twenty miles.

Sect. 2. No person or persons, or corporation, public or private, shall discharge, or cause to be discharged, into any pond in this Commonwealth used as a source of water-supply by any city or town therein, or upon whose banks any filter-basin so used is situated, or into any river or stream so used, or upon whose banks such filter-basin is situated, within twenty miles above the point where such supply is taken, or into any feeders of such pond, river or stream within such twenty miles, any sewage, drainage, refuse, or polluting matter, of such quality and amount, as either by itself, or in connection with other such matter, shall corrupt or impair the quality of the water for domestic use, or render it deleterious to health.

Sect. 3. The prohibitions contained in the two previous sections shall not be construed to destroy or impair rights already acquired by legislative grants, or to destroy or impair prescriptive rights of drainage or discharge, to the extent to which they lawfully exist at the date of the passage of this act. And nothing in this act contained shall be construed to authorize the pollution of any waters in this Commonwealth in any manner now contrary to law.

This act shall not be applicable to the Merrimack or Connecticut Rivers, nor to so much of the Concord River as lies within the limits of the city of Lowell.

SECT. 4. The State Board of Health shall have the general supervision of all rivers, streams, and ponds in this Commonwealth which are or shall be used by any city or town as sources of water-supply with reference to their purity, together with the waters feeding the same, except the Merrimack, Connecticut, and Concord Rivers. It shall be the duty of said Board to examine the same from time to time, and to inquire what pollutions exist, and their causes.

Whenever a violation of any of the provisions of this act is committed, the said Board may, if in its judgment the public health shall require, order any person or persons, or corporation, public or private, to cease and desist from such violation, and to remedy the pollution, or to cleanse or purify the polluting substances in such a manner, and to such a degree, that they shall be no longer deleterious to the public health before being cast or allowed to flow into the waters thereby polluted; *provided*, that before making such order the said Board shall assign a time and place for hearing the party or parties to be affected, and shall give him or them an opportunity of being heard thereon, and the orders hereinbefore provided shall be issued only after such notice and hearing; and *provided, also*, that upon the application of any city or town to said Board, alleging the violation of any of the provisions of this act, and the pollution of its water-supply thereby, it shall be the duty of said Board to grant a hearing upon due notification of the parties to be affected as aforesaid, and, upon proof of such violation, to issue the order or orders already mentioned in this section.

SECT. 5. The supreme judicial court, or any one of its justices, in term time or vacation, shall have power to issue an injunction to enforce the orders of the said Board of Health.

SECT. 6. The orders of the said Board of Health shall be served upon the party or parties found to have violated any of the provisions of this act; and such party or parties, if aggrieved thereby, shall have the right of appeal to a jury, and be subject to the provisions of law contained in the fifty-sixth and fifty-eighth sections of chapter twenty-six of the General Statutes, and chapter two hundred and sixty-three of the laws of eighteen hundred and sixty-five. During the pendency of the appeal, the pollution against which the order was issued shall not be continued, contrary to the order of the said Board.

SECT. 7. This act shall take effect upon the first day of July, in the year eighteen hundred and seventy-eight. [*Approved April* 26, 1878.]

With reference to the pollution of the Assabet River in Concord, by the sewage of the State Prison in that town, the Board have to report that their attention has been called by the chairman of the selectmen to the fact that the filth[1] is

[1] The exact words used are as follows: "I wish to inquire whether you have established any regulations regarding the emptying of the sewage from the State Prison in this town into the Assabet River, or not. I am credibly informed that it flows into the river apparently as if it came directly from the water-closets. If any regulations have been adopted in accordance with the statute of last winter, it would seem that they are disregarded or inadequate."

still discharged into that stream without the purification required by law, and that the Board have officially notified the proper officers of the prison that some remedy is required. The views of the Board had already been expressed on the subject at the prison itself, both before and after its occupation; and their secretary had visited the premises with Messrs. E. S. Philbrick and E. C. Clarke, as consulting engineers. The promise has been given, that the sewage will be utilized as soon as the proper works can be constructed; but the occupation of the new buildings having fully taxed the time and thoughts of the officers and inspectors, no adequate arrangements have, as yet, been adopted.

The Board have addressed circulars to all the boards of health, and to all their medical correspondents in the State, with an inquiry relating to all the sources of water-supply, and their present or future likelihood of contamination. The replies will be found tabulated under the head of Health of Towns, and will form the basis of an investigation for another year.

The present method of disposal of the sewage of the Prison for Women at Sherborn is in direct violation of the law just quoted; but no formal complaint has been made, except by the officers of the prison, on account of the offensive and nauseating odor; and the City of Boston purpose taking measures to protect their water-supply. The Board, of course, under the law, have no authority to interfere to stop the nauseating smells, nor, without a petition and hearing, to require the sewage to be purified effectually.

The establishment of a large slaughter-house and rendering buildings in Belmont, but near the Cambridge line, and close to their water-supply, has shown a weak point in our law, so far as the licensing of noxious and offensive trades is concerned, when the interests of more towns than one are involved.

The Board respectfully recommend that in similar cases the license of the authorities of all the towns concerned be required.

INTEMPERANCE.

The suggestions in the sixth report of the Board, of the advisability of better means of reforming drunkenness when it is a vice, and of curing it when a disease, have been re-

peated by a commission of distinguished citizens of Boston appointed by the mayor of that city. General attention has been so awakened to the subject in England, also, that there is now an exhaustive parliamentary inquiry into the whole matter, as a result of which four large octavo volumes of evidence have already been published. The fact is worth noting, too, that, in France, civil rights have been taken from confirmed drunkards.

That the present treatment of drunkenness by sentences of short duration is in the highest degree unsatisfactory, is generally admitted; that many reforms or cures are possible, has been amply demonstrated, at least in selected cases, by our best inebriate-asylums; and it seems highly desirable that, in proper circumstances, the law should authorize committals of drunkards for treatment in the same way as the insane. A more severe public judgment of drunkenness, in recent times, has undoubtedly tended to very much decrease its prevalence; and it is generally believed that light German beer is used more and more each year, at least in our State, to the exclusion of stronger liquors,—a change which it is, of course, desirable to hasten by legislation, so far as that can be done, either by removal of restrictions on the sale of mild liquors, and heavily taxing the stronger spirits, or by any other just and proper means.

Dr. F. A. Harris, one of the medical examiners under the new Massachusetts law, reports that of one hundred and seventy-eight investigations by him, during his first official year, "in no less than forty of the cases could the death be traced directly to the abuse of alcoholic stimulants; and the same cause is undoubtedly responsible, remotely, for a still larger number." The Board need add nothing to such a statement of fact, to indicate their appreciation of the importance of the question.

Syphilis and Prostitution.

Several times during the past eight years, the Board have been requested, both through formal communications and otherwise, to make an inquiry into the degree of prevalence of venereal diseases in this State, and to report whether there is any practicable method of restricting their spread. Indeed, in an official communication to the legislature, dated May 14,

1870, the Board included *syphilis as dependent on prostitution*, among the subjects to be investigated by them. Great as the evil is, falling often on persons guiltless of any licentiousness or violation of nature's laws, the difficulty of collecting any trustworthy facts, the pressure of other work from which it seemed possible to get more satisfactory results, and the too general disposition of communities to place such affections outside of the list of diseases, the prevention of which is a duty of the State, have thus far determined the Board to defer such an investigation until a more favorable time. The subject has often been considered from a purely moral point of view, or it has been ignored or purposely kept out of sight. But a fact cannot be ignored into non-existence; and it is the opinion of many thoughtful people, that most evils are increased by being kept in the dark or veiled by a sort of hypocritical unconsciousness.

Within a few years, attempts have been made to secure systems of legislative license and regulation in several of our States; and two distinguished physicians, in their addresses as presidents of the American Medical Association, have strongly recommended laws somewhat similar to those in force in some countries of Europe.

Doubtful as are some of the statements and conclusions from European experience, it can be said with certainty that no practicable medical examinations of prostitutes can make licentiousness safe; that it is by no means certain that the sense of security given by such laws does not, in some cities at least, so far increase improper indulgence as to make the sum total of consequent disease no less, even if proportionately so; that all systems which make it for the interest of prostitutes to conceal their vocation, and to drive them into the clandestine class, certainly increase the danger of infection; and that the character and morality of a community are not improved thereby. In England, the so-called "Contagious Diseases Acts" apply to only a certain number of military stations, for the sake of securing a degree of immunity to soldiers living lives of enforced celibacy. They have several good features in limiting venereal diseases, in apparently securing the reform of many girls who had given themselves up to bad lives, and in deterring a considerable number from entering upon a downward course. It is doubtful, how-

ever, whether these laws could be well applied to their civil population; and the experience of one of our American cities has apparently shown that, in this country, we are not at all likely to accomplish such a diminution of venereal diseases by restrictive laws, as in those lands where a rigid police system can be carried out.

Any such laws should, of course, apply as well to men as to women; for the weaker party has the same right to protection as the stronger, although, in the legislation even of England, there is the manifest injustice of attempting to secure immunity only for the men.

Many women begin, at least, to lead immoral lives to get their daily bread, and probably will continue to do so until they have a fairer opportunity in the struggle for existence. Their means for obtaining thorough training being very deficient, as compared with those of men, they have very much fewer chances of getting fairly remunerative work; and they not infrequently fall in spite of the best resolutions. The only remedy, of course, is to open every possible avenue to them, whereby they may become as independent as possible.

For the large number of women, as well as men, who lead lives of licentiousness by preference, little can be done beyond the condemnation of a well-educated and healthy public sentiment. They are seldom reformed; many of them drop out of the world on the principle of the non-survival of the unfittest; and, as a class, they injure society to no small degree when diseased, by spreading broadcast a loathsome malady, even if they do not commit the crime of marrying, and infecting their families.

If control of syphilis and prostitution seems impracticable in the present state of our public feeling, there is at least one thing which should be done; and that is, to give facilities for hospital treatment to the sufferers from venereal disease. In the opinion of the Board, this need is now an urgent one in our State, which, if properly met, may be the means of doing great good. With all its noble charities, Boston is an exception to the general rule of large cities, in that it does not properly provide for the treatment of the most contagious disease known, — one, too, in which the results are so far-reaching and disastrous, that they are often felt for a lifetime, and in succeeding generations, visiting the innocent

frequently with greater severity than the guilty. It should be remembered, too, that syphilis is not an infectious disease in the usual acceptation of the word; that it is communicated only by direct contact with the syphilitic virus; that there is no danger to other patients, therefore, in treating syphilitics in a general hospital, and that the hospital, while being a charity in the best sense of the word to the sufferer, is also the means of restricting that spread of the disease which otherwise is too likely to take place.

The Yellow Fever Epidemic.

The wide-spread visitation of yellow fever in our Southern States during the past year, whether arising spontaneously in our Gulf-coast cities and towns, or only by importation of the specific "germ" from those places where it is endemic, has directed thought anew to the insanitary condition of very many of our populous places, to the inefficient and incomplete registration of vital statistics in nearly all parts of the United States, and to the want of local, state, or general governmental attention to those laws of public health which are commonly thoroughly carried out only by well-organized boards of health supported by an intelligent public sentiment. Although the disease did not visit different places with a degree of severity proportionate to the prevalence of filth, yet the universal contamination of air, soil, and water, in all the places invaded, indicates that pollution of these great necessaries of healthy life was a potent factor in the causation of the epidemic, even if it were not the chief element.

It is impossible to say how the disease first appeared: it is the general belief of most Southern physicians, that its origin was this year, and when imported to the United States commonly is, in Havana, although competent and careful observers think that it develops spontaneously, also, in parts of the United States. One of the most experienced and critical students of yellow fever holds that it rarely spreads in clean places — only in the presence of filth; an observation which we consider to have been verified during the past year's epidemic. Comparatively little attention has as yet been paid to the establishment of boards of health, or to sanitary measures, in most parts of this country; and the

events of the last few years have rendered our Southern cities and towns especially unable to undertake the costly works that are necessary to remove filth so efficiently from all places where the human race congregates, as to give to all, or even to many, classes of people that pure air and pure water which are absolutely essential to health, and without which destructive epidemics are sure to occur from time to time.

New Orleans was, without much doubt, the central point from which the yellow fever of 1878 was distributed by infected clothing, goods, &c., to the various places far and near, as they happened to be exposed, chiefly through railroads and steamboats, in proportion as their sanitary conditions were such as to favor the spread of fevers, and provided a susceptible population were left to receive the poison. The efficiency of rigid quarantine to absolute exclusion of the "germ" of yellow fever, although rarely practicable, and the value of sanitary measures, even if falling far short of a desirable standard, seemed clearly demonstrated. "Disinfectants" proved of little use[1] against so powerful an epidemic.

From February to May inclusive, New Orleans lies below the level of the Mississippi River, being protected from inundation by levees. There is no underground drainage; about one mile in ten of the streets is well paved; the surface sewers are usually of wood in various stages of decay, allowing a varying amount of deposit of filth, according to the absence or not of rains; the sewage and surface washings which do not soak into the ground collect in inadequate surface canals or reservoirs, to be pumped by four machines into open ditches leading ultimately into Lake Pontchartrain, about ten miles distant, where there is only a slight tide; but there is really a considerable soakage into the marshes back of the city, where a rank vegetation is produced. Garbage is in

[1] "To chemically disinfect (in the true sense of that word) the filth of any neglected district, to follow the body and branchings of the filth with really effective chemical treatment, to thoroughly destroy or counteract it in muck-heaps and cesspools and ashpits and sewers and drains, and where soaking into wells, and where exhaling into houses, cannot, I apprehend, be proposed as physically possible; and the utmost which disinfection can do in this sense is apparently not likely to be more than in a certain class of cases to contribute something collateral and supplementary to efforts which mainly must be of the other sort" [*prevention* of filth]. — JOHN SIMON, F. R. S.

many cases thrown into the back yards or streets when not carried to a dumping-ground in the vicinity of the low lands. The ground-water lies from two to four feet below the surface of the soil; and the numerous privy-vaults, with imperfect brick walls and bottoms of earth, render universal contamination of the soil inevitable.[1] Even cemeteries are necessarily so shallow as to corrupt the air. Water-closets are not in general use except in some of the hotels. The water-supply from the Mississippi River is seldom used for drinking, inasmuch as it would require careful filtration for that purpose, but cisterns to collect and store unfiltered rain-water are chiefly depended upon; so that few people in New Orleans drink water which is free from a considerable degree of organic impurity.

In other places, there were the open ditch-like stream converted into a filthy sewer, an exposed and foul-smelling cemetery, and nearly always the privy in various conditions, some with shallow vaults and pervious walls which do not admit of proper cleaning, and others moved about over the surface of the ground, the filth being removed to gardens, or covered with earth or ashes; the wells, if any, almost certain to be polluted, and the unfiltered rain-water furnishing an unsatisfactory substitute for domestic use.

President Choppin, of the Board of Health, states that there were 4,500 deaths in New Orleans alone; he estimates that there were 25,000 cases of yellow fever in that city, and he places their loss from the epidemic at $10,572,000. It is not possible to get at the whole extent of the ravages of the disease, as the registration of deaths is too incomplete to enable us to do so; but it can be said with certainty that it visited eighty villages, towns, and cities, not seldom with the fatality of the black death of the fourteenth century. New Orleans alone probably lost enough money, in the few months of its prevalence, to have supplied the city with pure water in abundance and with good drainage.

As an immediate result of this very wide-spread and fearful scourge, it is confidently hoped that a national Board of Health will be eventually established at the proper time, and state and local boards at once, with the view to spread-

[1] The description of the sanitary condition of New Orleans is taken from the secretary's report published in the Boston Medical and Surgical Journal.

ing knowledge on sanitary science, and preventing future epidemics. To that end, the chairman and secretary of the Board were sent as delegates to the yellow fever conference in Richmond, held under the auspices of the American Public Health Association, where fifteen of the nineteen State Boards of Health then existing in the country were represented, and as a result of which an advisory committee was appointed, consisting of one prominent sanitarian from each State of the Union, to co-operate with the executive committee of the American Public Health Association in suggesting to Congress the best method of attaining efficient sanitary organization and administration throughout the States.

The lesson cannot fail to teach to the whole country the importance of attention to nature's laws; and we must not forget that filth-diseases still prevail to no slight extent in Massachusetts, where we have had over 5,000 deaths from diphtheria[1] in two years.

BOARDS OF HEALTH.

The law[2] with regard to the establishment of boards of health in the cities of the State was adopted in Cambridge,

[1] For the history, preventive measures, &c., in diphtheria, see the sixth seventh, eighth, and ninth reports of the Board.

[2] [Chap. 133, of the Acts of 1877.]

AN ACT RELATING TO BOARDS OF HEALTH IN THE SEVERAL CITIES OF THE COMMONWEALTH.

Be it enacted, &c., as follows: —

SECTION 1. In each of the several cities of this Commonwealth, except the city of Boston, the mayor and aldermen shall, in the month of January, in the year eighteen hundred and seventy-eight, appoint two persons, not members of the city council, who together with the city physician shall constitute the board of health of such city. The board so constituted shall enter upon its duties on the first Monday of February then next succeeding. The terms of office of the two appointed members shall be so arranged at the time of their appointment, that the term of one shall expire on the first Monday in February in each year, after the year eighteen hundred and seventy-eight; and the vacancy so created, as well as all vacancies occurring otherwise, shall in each of said cities be filled by the mayor, with the approval of the board of aldermen. The members of said board of health so appointed shall in each of said cities be subject to removal by the mayor for cause; and for their services they shall receive such compensation as the City Council may from time to time determine.

SECT. 2. Each of said boards of health shall organize annually by the choice of one of their number as chairman; they may also choose a clerk, not a member of the board; and they may make such rules and regulations for

Lowell, Worcester, New Bedford, Newburyport, Lawrence, Somerville, and Fall River; it was rejected in Fitchburg, Gloucester, Newton, Lynn, and Chelsea; no vote was taken on it in Haverhill, Holyoke, Salem, Springfield, and Taunton.

By the literal construction of the act, it could be adopted only on the day of election in November, 1877. It is desirable that the ten cities which failed to avail themselves of its privileges should have other opportunities to reconsider their action. The Board respectfully recommend the following law, which would enable all our cities to elect boards of health whenever they see fit to do so:—

AN ACT RELATING TO BOARDS OF HEALTH IN THE SEVERAL CITIES OF THE COMMONWEALTH.

SECTION 1. It shall be the duty of the mayor and aldermen in each of the cities of the Commonwealth which have not already voted to accept chap. 133 of the Acts of 1877, to notify and warn the legal voters of said cities to vote upon the acceptance of said act, at the then next meeting, in said cities respectively, for the election of city officers; *provided* the mayor and aldermen have been required in writing so to do,

their own government, and for the government of all subordinate officers in their departments, as they may deem expedient.

SECT. 3. The boards of health hereby constituted shall have and exercise all the powers vested in, and shall perform all the duties prescribed to, city councils or mayors and aldermen as boards of health, under the statutes and ordinances now in force in their respective cities; and shall have power to appoint such subordinate officers, agents, and assistants, as they may deem necessary, and may fix their compensation, and the compensation of the clerk before mentioned; *provided*, that the whole amount of such compensation shall not exceed the sum appropriated therefor by the city council.

SECT. 4. In each of said cities said boards of health shall annually, in the month of January, present to the city council a report made up to and including the thirty-first day of the preceding December, containing a full and comprehensive statement of the acts of the Board during the year, and a review of the sanitary condition of the city; they shall also, whenever the city council, or the standing committee thereof on finance, shall so require, send to the auditor of accounts an estimate in detail of the appropriations required by their departments during the next financial year.

SECT. 5. Said boards of health and the board of health of the city of Boston, in addition to the powers conferred upon them by existing statutes, are hereby authorized to prepare, and enforce in their respective cities, such regulations as they may deem necessary for the safety and health of the people, with reference to house-drainage and its connection with public sewers, where such connection is made.

SECT. 6. On the Tuesday next after the first Monday of November next, a meeting of the legal voters of each of the several cities of the Commonwealth shall be duly warned and called by the mayor and aldermen thereof, for the purpose of voting upon the acceptance of this act; and the same shall not take effect in any city unless accepted by a majority of the legal voters present and voting at said meeting. [*Approved April 17, 1877.*

thirty days prior to the time of holding said meeting, by fifty voters residing therein.

SECT. 2. In case of a severe epidemic, or of danger to the public health, the mayor and aldermen of any city in the Commonwealth where there is no board of health, may appoint such a board, in accordance with the provisions of chap. 133 of the Acts of 1877; *provided* they have been requested to do so by one hundred voters in their respective city or cities.

SECT. 3. This act shall take effect on its passage.

The ravages of preventable disease must be chiefly limited by intelligent action of local boards of health; and a large portion of the labor of the State Board of Health has been, so to speak, thrown away, for want of the proper authorities to carry out sanitary measures. It would be invidious to mention the names of individual boards in the cities and towns where most excellent sanitary work has been done, especially during the past year; for many others, doubtless, have been equally active and efficient. The Board cannot better express their own views of the great value to every community, of an efficient local health department, than by quoting as follows from the inaugural address of the mayor of Somerville: —

"As I took occasion a year ago to express the opinion that the city had made a mistake in voting to accept the health act passed by the General Court in 1877, I desire now to say that the experience of the past year has led me to an entirely different opinion from the one then expressed. The Board of Health has been in successful operation since its organization in the early part of the year; and, beside relieving the City Council of a large amount of work, I am satisfied it has accomplished more in the way of abating a large number of nuisances than it would have been possible to accomplish under the old law. It has also commenced a systematic examination of the house-drainage throughout the city, and to enforce wholesome rules and regulations in all cases of contagious diseases. Without attempting to assign the cause, it is a matter of congratulation that during the last three years the death-rate among us has been gradually diminishing. The following is the number of deaths in our city since its organization: —

		Rate per thousand
1872	400	24.30
1873	425	21.70
1874	490	22.96
1875	501	22.86
1876	444	20.18
1877	441	19.15
1878	385	16.21

"As the population of the city is larger than at any previous time, it is only reasonable to conclude from the above figures that the great work

done in previous years in abating nuisances that had long been the cause of an unenvied notoriety to our city, and the greater care exercised during the past year, have been among the causes that have contributed to this happy result. Somerville now ranks, if not the first, among the first, of the cities of the Commonwealth, in point of healthfulness. The rate is lower than the lowest given in the report of the State Board of Health for 1877."

To those cities and towns that remain still without boards of health, we would point out the fact that the preventable diseases each year cause fully twenty-five per cent more deaths than need be, if we even applied thoroughly the means of prevention which are well known, and which lie within our power to use. In confirmation of this statement, the Board refer to the mass of information with regard to diphtheria alone, which is contained in their last three reports, and to the small number of places where our knowledge of its causation is applied, incomplete though it be, although sufficient to vastly diminish the prevalence and fatality of the disease.

Indeed, in a considerable part of our State, although we have made great advances, as well as in the cooler latitudes generally, we can thank our climate chiefly, and not the sanitary condition of our streets and houses, that the yellow fever, which has so more than decimated many places at the South, has not been a scourge to us also. If we have accomplished much, there remains still much to be done.

Of the two hundred and seventy-nine towns from which replies to our circulars have been received, two hundred and sixty-two have boards of health composed of the selectmen alone; in six, a physician is added to their number; Bridgewater, Brockton, Edgartown, Hopkinton, Marblehead, Medford, Milford, Palmer, Plymouth, Wakefield, and Winchester, have elected boards of health;[1] in North Andover, the physicians in town generally compose the board; in North Adams and Hingham, boards were elected, but not according to the last law, and so did not serve.

It seems to the Board very desirable, that, *in towns*, the boards of health should be composed of the chairman of the board of selectmen, one physician, and one other gentleman not otherwise connected with the town government. In

[1] Also Holliston, Nantucket, Natick, Pittsfield, Revere, and Stoughton.

answer to inquiries on that point, it appears that the local boards themselves look upon such an arrangement —

Favorably in	147	cases.
Favorably where there is a doctor in town, in	6	"
Unfavorably in	41	"
Favorably of selectmen and one physician, in	14	"
Unfavorably in small towns, in	48	"
Favorably of a board independent of selectmen, in . . .	9	"
Board should be appointed by State Board of Health, in .	2	"
No reply	8	"

Ten answer, one each, for various proposals.

In regard to the manner of establishing such boards of health,

69 reply indefinitely or not at all.
133 reply that they should be appointed by the selectmen.
51 reply that they should be elected.
17 reply that they should be appointed, when not consisting of the selectmen.
10 think that the medical member should be appointed, and the others elected.

The local boards themselves, as may be seen by their testimony, are very strongly in favor of the change in organization of town boards of health, as suggested above; and no better evidence can be needed of the desirability of some improvement.

The Board respectfully recommend that in every *town* in the Commonwealth the board of health shall consist of the chairman of the board of selectmen and of two members to be appointed by the board of selectmen, both of whom shall serve for two years, to enter upon the duties of their office each alternate year; neither of whom shall be otherwise connected with the town government, one of whom must be a physician, and of whom either may be re-appointed at the expiration of his term.

The Law appointing Medical Examiners.

The abolition of the office of coroner and of coroners' juries, and the substitution therefor of trained medical men, "medical examiners," with a reference to the officers of the law and to the courts of the legal functions of the abolished office, have been attended with admirable results. The

medico-legal society, formed of medical examiners and of associate members, among whom the attorney-general, the district attorneys, and the members of the State Board of Health, are such *ex-officiis*, has already done excellent scientific work. Their suggestions in the future must be of great practical importance; and their annual returns promise valuable material for the information of the medical and legal professions, and for the legislature. The medical examiner for the northern district of Suffolk County made a report to Gov. Rice of his work for his first official year, ending June 30, 1878, which was referred by his Excellency to the State Board of Health. The opinion is expressed in that communication, that the actual cost to the State of the new system is one-third less than under the old method. The Board desire to express their sense of the great public benefit of having such annual reports from all the medical examiners.

The Regulation of the Practice of Medicine.

We respectfully commend to the attention of the legislature the experience of the State of Illinois, where, in one year and a half, fourteen hundred self-styled doctors are reported as having left the State, because they were unable to pass the examinations required. Of these, in round numbers, four hundred are estimated to have gone to Indiana, two hundred and fifty to Wisconsin, two hundred to Michigan, one hundred to Minnesota, and an unestimated number to Missouri. Although it has been in Illinois, and would be in this State, impossible to maintain in such a way as high a standard as is desirable, yet the good results are self-evident.

There should be a competent board of examiners for a similar purpose in this State; and such a commission should represent all the medical colleges which give satisfactory diplomas to their graduates.

Supervision of the Insane.

The Board desire to repeat the statement made by them in their eighth report (p. 14), that there are many reasons why a more methodical inspection of insane asylums and supervision of the insane than now exists in our State would be productive of great good, if wisely and faithfully carried

out. They do not share the suspicion of asylums which seems to be so common; but, at the same time, it should be said that there ought to be every possible safeguard for the protection of society at large, of the superintendents of the asylums themselves, and of people deprived of personal liberty. The work to be done in this regard cannot be laborious; it might be easily performed at no serious expense to the State, and without the formation of a new commission.

Registration of Vital Statistics.

The act to provide for the more accurate registration of vital statistics (chap. 174) passed by the legislature of 1877, if taken in connection with chap. 275 of the acts of 1872, was thought to be sufficient to meet all requirements. A year's experience has shown a few defects in it, although great improvements have followed upon its enforcement. The Board, after conferring with the Secretary of the Commonwealth, has suggested some changes, which are as follows, the additions to the law of 1877 being indicated in Italics, and the removals from it in brackets.

Section 1. No human body shall be buried, or removed from any city or town, until a proper certificate has been given by the clerk or local registrar of statistics to the undertaker or sexton, or person performing the burial, or removing the body. This certificate shall state that the facts required by chapter twenty-one of the General Statutes have been returned and recorded; and no clerk or local registrar shall give such certificate or burial-permit until *the undertaker or sexton, or, if no undertaker or sexton is in attendance, the person performing the burial or removing the body has obtained* the certificate of the cause of death [has been obtained] from the physician, if any, in attendance, at the last sickness of the deceased, and *has* placed *it* in the hands of said clerk or local registrar: *provided* that, in those cities and towns where local boards of health have been established, *said board may require* the certificate of the cause of death *to* [shall] be approved by [such board] *them* before a permit to bury *or to remove the body* is given by the registrar or clerk.

Upon application, the chairman *or other member* of the local board of health, or any physician employed by any city or town for such purpose, shall sign the certificate of the cause of death to the best of his knowledge and belief, if there has been no physician in attendance. He shall also sign such certificate, upon application, in case of death by dangerous contagious disease, or in any other event when the certificate of the attending physician cannot, for good and sufficient reasons, be early enough obtained.

In case of death by violence, the medical examiner attending shall furnish the requisite medical certificate.

SECT. 2. *Every undertaker or person performing the duties of an undertaker shall be licensed each year by the mayor and aldermen, or city council, or by the board of selectmen of the city or town in which he resides; and said mayor and aldermen, or city council, or selectmen shall have authority to withhold or withdraw such license for sufficient cause. And no undertaker or other person shall perform the duties of an undertaker in burying or removing a body without such license or special permission.*

SECT. 3. Any person violating the provisions of this [section] *law* shall be punished by a fine not exceeding [twenty-five] *twenty* dollars, *to be imposed by any court of competent jurisdiction.*

SECT. 4. This act shall take effect on the first day of May, in the year eighteen hundred and [seventy-eight and] *seventy-nine. Chap. 174 of the Acts of 1877, and* all acts, and parts of acts, inconsistent herewith, are hereby repealed.

[Approved April 23, 1878.]

It is desirable that the whole system of registration should be carried out by officers not subject to frequent change, and that in the large cities there should be several registrars of vital statistics, at least one for each ward, so as to encourage the prompt registration of births. These vital statistics, collected by the registrars, should be referred to the local boards of health, when there are such, for revision, tabulation, comment, and publication.

By request of the Secretary of State, the State Board of Health will edit the registration report of the State, and will act in co-operation with that office in securing accuracy and completeness. It is believed that this will be the best practicable arrangement, whereby the skill and experience of the officers now in charge of the collection and tabulation of the statistics will be still available in that difficult and important work. Moreover, the facts necessary for their purposes will be readily procurable by the Board of Health.

POISONING BY ARSENIC.

The occurrence of cases of poisoning, from time to time, through the use of arsenical colors in wall-papers, &c., suggests the propriety of a respectful recommendation that this matter should be controlled by proper legislation. Of a number of samples of colored papers, intended to be used largely by children, all but one of the greens and two of the reds were recently found by Professor E. S. Wood to contain large

amounts of arsenic; one brown and one blue contained a certain amount. The dealer was requested to withdraw them from the market, and the public were warned of them through the newspapers.

It is the opinion of the Board that laws should be passed prohibiting the manufacture or sale of all articles improperly containing arsenic.

Impure Ice.

The results of chemical examinations of ice, made by Professor Wood and Professor Sharples, published in connection with the report of the hearing in the case of *Cambridge vs. Niles Brothers*, are especially commended to the attention of sanitarians and others, as corroborating the statements made by Dr. A. H. Nichols, in his article on that subject in the seventh report of the Board, and as showing the incorrectness of the general belief that ice always, in freezing, is freed from any impurities that the water might contain, especially in deep water.

The special reports and investigations made during the year are as follows: —

Hospital Homes for the Insane.

By T. S. Clouston, M.D.

The subject of insanity and of the proper provision for the insane has been treated in the third and fifth reports of the Board, by Dr. Edward Jarvis, and in the eighth by the secretary. Dr. Ray, Dr. Earle, and the late Dr. Tyler had been invited to contribute papers on mental hygiene, but were unable to do so. It has seemed desirable to publish, also, an essay upon the construction of hospitals for the treatment of mental disease according to the most advanced ideas which have been brought to the test of actual experience. In other words, the Board have wished to present, for the construction and management of insane asylums, plans and general rules, not perfect, of course, as applied to all countries and all peoples and all social conditions, but such as might serve the same purpose as the elaborate work which has been done in a similar direction by the trustees of the Johns Hopkins Hospital, now building in Baltimore. It is a matter of

congratulation to them, that a gentleman of Dr. Clouston's well-known accomplishments and experience has been able to accede to their urgent request to prepare such a report, or, to quote the author, "a practical guide for practical men," the results of his fifteen years' experience as medical superintendent of two important hospitals. It is commended to the careful study of all who are interested in the treatment of the insane by every appliance which science and medical skill and experience can suggest, to cure when that is possible, and otherwise to administer comfort and happiness.

The questions of ventilation, heating, &c., were purposely omitted from the present paper, inasmuch as those subjects have been treated quite exhaustively by writers whose works are readily accessible.

The Growth of Children.

By H. P. Bowditch, M.D.

This paper is a supplement to that already published in the eighth report of the Board. The subject is one of such great interest, that it is attracting more and more attention each year, as the preservation of health and the standards of measuring individual or national growth and strength are constantly more carefully considered, as legitimate subjects for scientific inquiry. It is hoped that the Board may be able to be the means of inaugurating a system of this kind generally in the various institutions of the State, which would be of great value, not only in the immediate results of presenting interesting statistics, but still more in the generally increased thought, which all subjects connected with the healthy development of the race would receive. The suggestions and directions at the close of the paper, with regard to the best methods of conducting these inquiries, will be of especial use to future investigators.

The Department of Physical Education and Hygiene in Amherst College.

By Edward Hitchcock, M.D.

The importance of proper physical training for young men, and the admirable results which have been got in one of our Massachusetts institutions, are so clearly set forth by the writer, that the strong recommendation of the Board can

hardly be needed in order to induce the creation of a similar department in all schools and colleges. The value of having a thoroughly-educated physician as an adviser in matters concerning health, who can be consulted at any time by the students, is self-evident; and it is also forcibly impressed upon the minds of not a few persons, who often have occasion to see how ignorant, in regard to simple questions relating to such subjects, many of the graduates of even our best colleges are.

Coal-Gas from Heating-Apparatus.

By Frederic Winsor, M.D.

The practical nature of the inquiry into this subject is fully illustrated in the citation, at the beginning of the paper, of those fatal cases which first attracted the writer's attention to that matter. The common use of close stoves of some sort, and generally with anthracite coal for fuel, throughout the State, must be attended with serious results, unless the precautions are observed which are suggested by Dr. Winsor. A gas, which may in moderate quantities produce death, should be so carefully guarded against, as to render its presence in dwelling rooms or sleeping rooms almost an impossibility.

Common Defects in House-Drains.

By E. C. Clarke, C.E.

The questions of sewerage and house-drainage are so intimately associated, that the public health requires each to be managed with the skill and experience of the accomplished engineer. Perfection in the one may be rendered to a great extent inoperative, if gross defects in the other are allowed to exist. As the Board were well aware that the house-drainage in most of our cities and towns is, in the vast majority of cases, entirely inadequate to secure protection from the dangerous influences of sewer and drain gases, they invited Mr. Clarke to report to them such defects as had been brought to his attention in Boston, believing that they would represent those which commonly exist where the water-carriage system has been introduced, and that such knowledge would furnish the best basis for the application of the proper remedies. Similar faults would be found in

the sewers of our cities and towns, but that is a point which does not come within the scope of the present inquiry.

In the first place, it should be said that house-drainage is a matter requiring the most careful attention and study of the trained sanitary engineer; it should never be wholly intrusted to the plumber, or mason, or drain-layer, as is so commonly done even by very intelligent people.

Second, House-drains, soil-pipes, &c., should always be under the control of the authorities of cities and towns, and should never be laid except under a rigid enforcement of the most stringent regulations, the most important of which is, that *they should always, within the house, be in such a position as to admit of frequent and thorough inspection.*

Third, Accurate plans of all house-drainage and its connections with the public sewers should always be kept, in duplicate; one to be at the central office, and the other at the house itself.

For the necessary details with regard to this subject, the reader is referred to the paper presented this year. The Board desire to add their recommendation to the writer's, that, in all our large cities at least, there should be a department of public works, under whose control all such matters would naturally come.

A Contribution to the Study of Ventilation.

By Edward Cowles, M.D.

Several experiments made by Dr. Cowles at the Boston City Hospital, with the assistance of Professor Wood, in performing the chemical examinations, have proved so interesting and suggestive with reference to the general principles of ventilation, diffusion of gases, &c., that a request was made by the Board to have the results of these investigations prepared in a form suitable for publication in their annual report. The excellent results in the surgical treatment of what are ordinarily difficult cases are no less interesting than the simplicity of the methods in use, and the completeness of the frequent changes of air which have been obtained. The principles determined are, of course, equally applicable to all buildings.

Health of Towns.

The Board have added each year to the number of their medical correspondents, in some cases having several in one town. Their voluntary assistance during the past year, as previously, has been of immense value to the Board and to the community. Their replies to the usual annual circulars, together with the answers to other questions from the local boards of health, will be found summarized in the usual place, and they contain information of great interest.

The registrars of many of the populous places in the State have the thanks of the Board, for continuing their kind labors in sending weekly returns of the condition of the public health, as indicated by the death-rates. These, of late, have been published in "The Daily Journal," each Thursday, in a somewhat different form from that previously used, as their greater accuracy admits. A fuller report is also published in "The Boston Medical and Surgical Journal:" —

Several thousand circulars of the Board, on scarlet-fever, diphtheria, and hydrophobia, have been distributed throughout the State during the year; and many local boards have adopted the provisions therein suggested for restricting the ravages of the contagious and infectious diseases. These were printed in the last report of the Board. In the present report will be found a circular with reference to drainage, &c., where there are no sewers.

The value of a library on sanitary matters, easily accessible for reference, has been clearly shown in the frequent calls for information upon matters of importance to health, by physicians, engineers, and officers of boards of health. This library is a useful feature in the work of the Board; it increases in extent, and therefore in usefulness, each year.

The retirement from office of Attorney-Gen. Train affords the Board an opportunity of expressing their cordial thanks for the very generous and valuable assistance which he has always most kindly given them, on the many occasions when it has been necessary to ask his advice.

The thanks of the Board are due to Dr. W. L. Richardson, for his intelligent and efficient management of the duties of the office of secretary during the past summer, while the secretary of the Board was absent, for the purpose of studying sanitary questions, in Europe.

A table of the metric system, and the usual statement of the expenses of the Board, are given on the next two pages.

The expenses this year fall somewhat below the appropriation. Although the work of the Board has of late very much increased, especially by recent acts of legislature with regard to pollution of streams and water-supplies, and although they are now obliged to pay a clerk out of their appropriation, yet no additional sum has been asked for since the first complete year of their existence.

All of which is very respectfully submitted.

HENRY I. BOWDITCH,
ROBERT T. DAVIS,
RICHARD FROTHINGHAM,
DAVID L. WEBSTER,
JOHN C. HOADLEY,
THOMAS B. NEWHALL,
CHARLES F. FOLSOM,
Members of the State Board of Health.

The Metric System.

LENGTH.

1 Myriameter,	. Mm.	(10,000 m.)	= 6.2137 miles.	
1 Kilometer,	. Km.	(1,000 m.)	= 0.62137 mile.	
1 Hectometer,	. Hm.	(100 m.)	= 328.0833 feet.	
1 Decameter,	. Dm.	(10 m.)	= 393.7 inches.	
1 Meter,	. m.	(1 m.)	= 39.37 inches.	
1 Decimeter,	. dm.	(0.1 m.)	= 3.937 inches.	
1 Centimeter,	. cm.	(0.01 m.)	= 0.3937 inch.	
1 Millimeter,	. mm.	(0.001 m.)	= 0.03937 inch.	

SURFACE.

1 Hectare,	. Ha.	(10,000 sq. m.)	= 2.471 acres.	
1 Are,	. a.	(100 sq. m.)	= 119.6 square yards.	
1 Centare	. ca.	(1 sq. m.)	= 1,550 square inches.	

CAPACITY.

1 Kiloliter or Stère,	. Kl. or st.	(1,000 l.)	= 1.308 cubic yards	= 264.17 gallons.
1 Hectoliter,	. Hl.	(100 l.)	= 2 bushs. and 3.35 pecks	= 26.417 "
1 Decaliter,	. Dl.	(10 l.)	= 9.08 quarts	= 2.6417 "
1 Liter,	. l.	(1 l.)	= 0.908 quart	= 1.0567 qts. (1.761 imperial pints.)
1 Deciliter,	. dl.	(0.1 l.)	= 6.1022 cubic inches	= 0.845 gill.
1 Centiliter,	. cl.	(0.01 l.)	= 0.61022 cubic inch	= 0.338 fluid ounce.
1 Milliliter,	. ml.	(0.001 l.)	= 0.061 cubic inch	= 0.27 fluid drachm.

WEIGHT.

1 Millier or Tonneau,	M. or T.	(1,000 Kg.)	= 1 Kl. or 1 Cu. m.	= 2204.6 lbs. (avoirdupois.)
1 Quintal,	. Q.	(100 Kg.)	= 1 Hl. or 0.1 Cu. m.	= 220.46 pounds.
1 Myriagram,	. Mg.	(10 Kg.)	= 1 Dl. or 10 Cu. dm.	= 22.046 "
1 Kilogram,	. Kg.	(1,000 g.)	= 1 l. or 1 Cu. dm.	= 2.2046 "
1 Hectogram,	. Hg.	(100 g.)	= 1 dl. or 0.1 Cu. dm.	= 3.5274 ounces.
1 Decagram,	. Dg.	(10 g.)	= 1 cl. or 10 Cu. cm.	= 0.3527 ounce.
1 Gram,	. g.	(1 g.)	= 1 ml. or 1 Cu. cm.	= 15.432 grains.
1 Decigram,	. dg.	(0.1 g.)	= 0.1 ml. or 0.1 Cu. cm.	= 1.5432 "
1 Centigram,	. cg.	(0.01 g.)	= 0.01 ml. or 10 Cu. mm.	= 0.1543 grain.
1 Milligram,	. mg.	(0.001 g.)	= 0.001 ml. or 1 Cu. mm.	= 0.0154 "

One kilogram is equal to a weight represented by one liter of distilled water at 4° C. In the centigrade scale 0 (32° + F.) is the freezing point: 100° + (212° + F.) is the boiling point. Five degrees C. corresponds to nine degrees F.

All measures in the metric system are derived from the meter, and their names express their values. Some of the names in the French system (like our " dime ") are not in practical use; e.g., hectometer, decagram, etc.

One inch = 2.5 centimeters nearly; one quart (wine measure) = 0.946 liter; one pound troy = 0.373 kilogram; one acre = 0.4046 hectare.

EXPENSES OF THE BOARD.

Messrs. Rand, Avery, & Co., printing and stationery	$622 78
Messrs. Fairbanks & Co., postage and stationery	348 27
Travelling expenses	124 88
Horse and hack hire	58 00
Messenger	43 70
Express	97 73
Telegrams	3 35
Expenses of delegates to Yellow-Fever Conference in Richmond	88 25
Books	156 07
Binding books and pamphlets	95 13
Fifty maps of Massachusetts	7 50
Reference map of Massachusetts	50 95
Prof. E. S. Wood, chemical examinations	210 00
Prof. S. P. Sharples, chemical examinations	30 00
Prof. W. B. Hills, chemical examinations	50 00
Prof. W. Ripley Nichols, chemical examinations	20 25
Prof. H. B. Hill, chemical examinations	10 00
Clerical services	235 76
"Boston Journal"	97 60
Heliotype Printing Company, drawings	130 00
" " " 200 circulars	6 00
Office furniture	94 00
Revising map of Housatonic Basin	10 00
Indexing Ninth Report	34 00
Anemometer	20 33
Stenographic report of hearing, — Cambridge *v.* Niles Bros.	53 55
Map of Cambridge water-supply	28 00
Postage	20
Special reports and investigations (E. C. Clarke, C.E., Dr. T. S. Clouston, Dr. E. Cowles, Prof. E. Hitchcock, Dr. F. E. Oliver, Dr. F. Winsor, Dr. J. R. Chadwick)	1,072 97
T. H. Hay, Clerk	500 00
	$4,299 27

AN ASYLUM, OR "HOSPITAL-HOME,"

FOR TWO HUNDRED PATIENTS: CONSTRUCTED ON THE PRINCIPLE OF ADAPTATION OF VARIOUS PARTS OF THE HOUSE TO VARIED NEEDS AND MENTAL STATES OF INHABITANTS: WITH PLANS, ETC.

BY

T. S. CLOUSTON, M.D.,

PHYSICIAN-SUPERINTENDENT OF THE ROYAL EDINBURGH ASYLUM FOR THE INSANE AT MORNINGSIDE, EDITOR OF "THE JOURNAL OF MENTAL SCIENCE," LECTURER ON MENTAL DISEASES IN THE UNIVERSITY OF EDINBURGH.

AN ASYLUM, OR HOSPITAL-HOME.

Introductory.

In planning the asylums for the insane, built seventy years ago, the dominant idea in the minds of their architects was secure custody: in the case of those built about thirty years ago, the idea of curing the patients had modified in a marked degree the jail-like features of the earlier buildings. Since that time, under the new regime in this country, improvements in the character of the hospitals for the insane have been going on steadily. Within the last ten years almost a new departure has been made, at least in Scotland, in the same direction.

For twenty-two years there had been used for gentlemen patients at Morningside Asylum, as an ordinary part of the institution, a cottage at the extreme end of the grounds, nearly half a mile from the main building, as a residence for some of the patients.[1] In every respect the cottage was left as it had existed, — as a small farmhouse, — its doors, windows, rooms, &c., being left unaltered in any way. For about the same period, two pavilion wings at the "East House" of the same asylum had been treated as two ordinary houses, — the doors never being locked except at night. At the Royal Asylum, Cheadle, Manchester, Mr. Mould, fifteen years ago, began to erect villa residences in a row near the asylum, for patients' use, in which no locked doors or special asylum contrivances for security existed. About twelve years ago, Dr. Sibbald at the District Asylum for Argyllshire, in Scotland, for rate-paid patients alone, had to take down the walls of his "airing courts," which had, up to that time,

[1] A view of this, from a photograph, is to be found in the Annual Report of the State Board of Health of Massachusetts, 1877, p. 370.

been an essential feature of all asylums in this country, and found that his patients were, on the whole, better without them; and since that time "airing courts" or circumscribed spaces enclosed by high walls, ha-ha fences, or railings, for security against the escape of the patients who are exercising in them, have been taken down or disused in every asylum in Scotland. About nine years ago, Dr. Batty Tuke, at the Fife and Kinross District Asylum at Cupar, for pauper patients, put on ordinary locks, with handles, on the outer doors of several of his wards, calling it the "open-door system;" and now there is scarcely an asylum in Scotland that has not some wards where the access to them and the exit are as free as in any ordinary house or hospital. In November, 1878, I visited the newest Scotch asylum at Lenzie, near Glasgow, and walked through and through every part of it without any key. Dr. Rutherford has brought the "open-door system" into use in every part of this institution during the working hours of every day. Five years ago, I had all the old windows taken out at the "East House" for the higher classes at Morningside, and large sheets of plate-glass put in, and am gradually extending this over the "West House," which is for the poor patients. In the reconstructed sick ward for paupers here, there is nothing but large plate-glass used; while in the new wings and dining-rooms for ladies and gentlemen at the "East House" here, nothing but ordinary windows were put in, while in the general arrangements, furnishings, &c., I took a first-class hotel as my model, and not any pre-existing asylum at all. Our patients now dine in rooms, the walls of which are chiefly two glass screens with plants between, forming a conservatory on each side of the room; and the general arrangements of which are precisely those of a *table d'hôte* in a good Swiss hotel in the summer.

As regards the improvement in the furnishings, decorations, and amenities of asylums, the most wonderful strides have been made, especially in the English county asylums, under the auspices of their medical superintendents and the commissioners in lunacy. For a stranger to go into one of the best of such institutions now, is to find himself in what seems more like a palace than a hospital for the pauper insane.

The conclusion to be come to from these facts is, that all the insane cannot be so dangerous as had been supposed; that at least many of them can be managed and treated without any special contrivances of buildings, and that many of them can live in houses just like those inhabited by the general population.

Even if individual asylum physicians should be proved to have gone to extremes on some points in relaxing the old supposed safeguards that surrounded the insane in asylums, yet I maintain that even their indiscretion has done good. It has had for its object the restoration to ordinary conditions of life of a portion of humanity that lay in fetters and chains one hundred years ago. The greatest advances in the treatment of the insane, from Pinel's and Tuke's time onward, have been made by running risks for the sake of benefiting the patients. Among a British people, at all events, a man's happiness is always diminished by whatever lessens his liberty, and suggests undue control. The problem of governing an insane population is now seen to be simply the old one of combining liberty and order in the greatest possible degree. It would be inexcusable if any asylum were now built with all its arrangements suited for the worst class of patients, and if the quiet and harmless patients, as well as the dangerous, were made to live in wards and rooms full of contrivances that cannot but suggest control, distrust, and imprisonment.

PRINCIPLES OF CONSTRUCTION, ETC.

I think I am justified by modern Scotch and English experience, as well as by my own, in laying down the following principles for the construction of an asylum for the insane, of the size I have mentioned (two hundred patients); and suitable for every class of the population, which, I understand, is an essential element in the solution of this problem in America.

1. The site should be somewhat elevated, sloping, and exposed towards the south; sheltered, if possible, from the prevailing winds; the subsoil dry; the buildings to be rather nearer the northern than the southern boundary of about one hundred acres of wooded land, with an accessible water supply of fifty gallons for each patient a day, within two

miles of a large town (that with a medical school being selected, if any such exists).

2. The buildings being intended for the treatment with a view to recovery, and the care, of a number of persons, who, though all mentally affected, are individually and in classes in different states of mind as regards the following points: *a.* Safety to themselves. *b.* Safety to others. *c.* Intelligence. *d.* Curability. *e.* Capacity for social intercourse and enjoyment. *f.* Daily habits of life. *g.* State of bodily health. *h.* Capacity for useful and other employments of entirely different kinds. *i.* Capacity for joining in amusements of different kinds. *k.* Necessity for care and attendance on the part of others. *l.* General trustworthiness: it necessarily follows that uniformity of accommodation and arrangements throughout the buildings should be most carefully avoided.

3. At one end of the scale, we have the insane who, as regards their mode of living, differ so little from the sane, that accommodation precisely like that afforded by the ordinary houses to which they have been accustomed is quite suitable for them.

4. At the other extreme are the deliriously maniacal, the intensely suicidal and homicidal, the paralyzed, those absolutely enfeebled in mind, and those very weak in body, for whom very special hospital accommodation has to be provided suitable to their needs.

5. There are intermediate classes who require modified supervision, nursing, attention, and, therefore, accommodation intermediate in character between those two extremes.

6. It should be a principle, never departed from, that the structures and arrangements that are necessary for the worst classes of patients should not be used for the best.

7. The special structures and arrangements for the treatment of the worst class should be as little special as possible, consistently with fulfilling their purpose, and should be modelled on medical and humanitarian, not prison principles. They should all be arranged so that they imply unceasing attention and vigilance on the part of the skilled and responsible officials and attendants: any thing whose object or effect is merely to save trouble and watching in the treatment of an acute case of mental disease may be regarded as utterly to be condemned.

8. All things that give an air or sense or feeling of confinement should, as far as possible, be avoided; many of the insane being super-sensitive in regard to the effect of their surroundings.

9. Every thing that produces "cheerfulness" of effect, inside and outside an asylum, should be most carefully studied, down to the minutest detail of painting and furnishing. This has been abundantly proved to be of the utmost importance for healing, hygiene, and happiness. Variety in the shape, size, and aspect of buildings and rooms, tends to interest, rouse, and cheer the patients, when they pass from one into the other.

10. An asylum should have every sort of strictly medical appliance of construction and arrangement for isolation, trying and studying the effects of drugs and treatment, baths of all kinds, — Turkish and medical, — microscopic, necroscopic rooms, &c.; every thing, in fact, to encourage and facilitate medical study, investigation, and treatment of the individual cases.

11. It should be remembered, in constructing and furnishing an asylum, that the chief things of which insane patients treated in asylums complain are: *a.* Removal from home. *b.* Being "locked up." *c.* Want of employment for which they are paid, and in which they take an interest. *d.* Control by attendants. *e.* Monotony of life. *f.* Association with "lunatics," meaning thereby fellow-patients worse in some respects than they are. It follows, that in constructing and furnishing the buildings of an asylum, and arranging its various parts, great care should be taken to provide for liberty, domesticity, classification, employment, amusement, and social intercourse between those who will enjoy it. Opportunities must be given for the creation of an artificial home life, as nearly like the natural as is possible.

12. It is impossible, in carrying out the foregoing principles, to avoid all risks of sudden impulses to violence, suicide, escape, &c.; but my experience is, that such risks are best avoided by a careful daily study and observation of the individual cases by the superior officials, and more especially by the medical officers. I often deliberately run risks for the sake of the happiness and cure of my patients; and I think this principle has by no means been carried out far enough.

Who, if he had his choice before he became insane, would not prefer that the risk of suicide should be run in his treatment, if by that means there was any chance of his being saved from falling into dementia? If boys were brought up on the principle that they should run no risk of accidents, or even were ordinary houses or manufactories built, or carriages constructed, or railways run, on this supreme principle, "life would not be worth having" for any of us. I maintain that there are infinitely worse things in asylum management than "accidents."

13. After all, the risk of accidents is best met, and the necessity for irksome supervision and precaution avoided, by placing the patient in such circumstances that he works and plays, and forgets his morbid humors. Irritability, and consequent unhappiness, are best diminished by giving scope for expending muscular energy in the open air. To know how best this can be done for each case, implies a study of the patients that is good for patient and doctor. I have seen both systems tried. When I came to Morningside Asylum, in 1873, there were high-walled airing courts, a "refractory ward," and only about one hundred and ten male patients out of three hundred going out to the garden and workshops from the "West House;" while it was the rule, that no patient was sent out to work in the garden without special orders. Now we have no "refractory ward," no airing courts; two hundred and ten patients go out to gardens and workshops every day, besides twenty-five who assist attendants. The rule is, that all the patients go out who are not under orders to stay in; but then an assistant physician sees them go out every morning, and turns back any patient who is not fit to go. I never really knew my "refractory patients" till I had to provide each with suitable employment; and some of the very worst, who had been for years reckoned dangerous men, are now the most useful workers we have. One such man, a perfect type of "monomania of suspicion," who used to have a daily fight with some one, is now absolutely the most profitable inmate of the institution, making and mending every tin and copper dish in the place. If fearful sounds are heard in the workshop court, it is known that "Joe" is taking it out of his imaginary enemies (for he still has the former delusions), by ferociously hammering a flat tin plate

into a form suitable for a kettle. No sane man I ever saw could do it so quickly. If he has a fight, it is only on a Sunday.

14. Patients should nearly all (except the sick and weak) dine in a central dining-room in association, for the following reasons: *a.* The meals are thus more hot and comfortable. *b.* The service is better. *c.* The supervision by medical and superior officers is more complete. *d.* There is a variety in the life, change of scene, and a means of passing the time secured. Who that has lived in a hotel has not felt the charms of going to the *table d'hôte*? *e.* The increased self-respect that is implied in extra attentions to dress and personal appearance is thus best secured. Since we began to use a common dining-room here, several inveterately untidy patients have been cured of their slovenliness of dress. *f.* Self-control is taught. The public opinion of the room or the table won't tolerate noise or disturbance. New patients get to feel this at once. *g.* The wards and parlors are thoroughly aired and ventilated during the absence of the patients.

15. The dining-rooms should be large, lofty, and very well lighted, and should have a totally different character, as regards color, decoration, and architecture, from the wards and parlors. The Swiss hotel-keepers have long ago found this out.

16. The passages to the dining-rooms should be constructed chiefly of glass, to secure cheerfulness. Thus constructed, they afford a grand opportunity, which has never yet in any asylum been fully taken advantage of, for being a "winter-garden," fitted with evergreen hardy plants. Looking after those would afford a pleasant kind of work to the patients during the winter, when they have no garden work, and can't get out. Thus treated, they afford delightful exercise and smoking corridors for many others and especially for excited patients when they cannot go out. Some of the glass corridors to the Pavilion blocks at the Garlands Asylum, Carlisle, when I was there, were brilliant with flowers; and so are now the passages to the dining-rooms here, thus producing a most pleasing effect on the minds and spirits of the patients.

17. The beneficial psychological effects on the patients, of

bright, cheerful color in the wards, dining-rooms, and passages of asylums, have by no means as yet been sufficiently considered. I have had nearly the whole asylum here tastefully painted in most brilliant colors by the very best and most artistic colorist house-painter in Edinburgh, with very good results. I maintain that money is thus well spent in painters' bills. I have used for the same purpose somewhat lavishly, in the passages, Minton's floor-tiles of bright colors, stained glass in the windows, &c.

18. Drawing-rooms for associated amusements of both sexes, billiard-rooms, &c., should be provided.

19. Workshops of many kinds should be a *sine quâ non* of every asylum, and one large "general amusement workshop," where the amateurs of all trades can find suitable tools, materials, and room for even their perverted ingenuity. I had a man who for five years provided himself with a most engrossing occupation in trying to construct a machine for perpetual motion. I have now a man who does so, in making toy chairs out of sticks cut in the grounds, with no tool but a penknife, and no fastenings but pins. For ten years a man here was made supremely happy by employing himself in making grotesque garden-seats for the grounds, out of twisted sticks, which he whittled into wooden serpents with staring eyes, little imps with long ears, and repulsive demons with cloven feet. The faculty of constructiveness, as perverted among the insane, affords a field for a most interesting psychological study.

20. A gymnasium should be provided.

21. One of the large parlors or public rooms should be so arranged that it can be used as a school in the evenings.

22. All the special arrangements of rooms, window-shutters, strong-rooms, padded rooms, &c., should be as little prominent and offensive as possible; and, above all, they should not be suggestive of what they are intended to prevent. I don't advocate *insecure* arrangements, however. Many special contrivances are capable of being masked. Strong-rooms, strong window-shutters, and others can be altered in effect when not needed.

23. A patient laboring under an acute attack of insanity should have an extra abundance of — *a.* fresh air; *b.* water for bathing; *c.* floor-space in his parlor, and room for a good

walk in a corridor of some sort; and, *d.* he should not be along with too many others.

24. Many asylum patients are in such a condition that they need most what is understood as ordinary "nursing;" and for this female nurses are, on the whole, the best. For the greater number of this class an "infirmary ward" is the best provision, where all the arrangements are somewhat like those of an ordinary hospital.

25. All the parlors and some of the bedrooms should have open fireplaces. If other heating is required, it should be done on scientific principles by steam-pipes, which will be also needed to keep the frost out of the glass corridors, and away from the plants in the "winter-garden."

26. Ventilation should be provided for by: *a.* Open windows. *b.* Open fireplaces. *c.* Gas-burners having openings over them communicating with flues, to remove the foul air and create a movement in the upper stratum of air in the room. *d.* External openings in outer and partition walls, opposite the ends of the joists under each floor, communicating with the open spaces between the joists, and those again with openings round the cornices, so that, whichever way the wind blows, there shall be a current of fresh air crossing the whole building among the joists. For very cold climates the external openings may be made to shut during the great frosts. *e.* Archimedean screw exhausters in all the roofs and tops of the glass cupolas in the one-story buildings. *f.* Special exhausting flues in the three-story block for "acute" and admission cases, communicating with each room at one end, and with a large chimney at the other.

27. All locks of doors to have handles to open them, and ordinary spring latches, but capable of being locked and double-locked by a common key.

28. Double roofs, with a non-conducting medium between, to be everywhere used.

29. The walls of certain of the bedrooms should be made double, with cotton-waste or something of that sort between, to prevent the sounds from noisy patients disturbing and keeping awake those near them.

30. A special wing should be thrown out, containing rooms for a few patients who would disturb the others and the general quiet of the house at night.

31. All windows, except those of a few of the bedrooms, should be of three-eighths-inch plate glass, four squares to a window in second and third stories, and two squares to a window on the ground floor.

32. All the day-room windows should reach to within two feet of the floor, and some of those on the ground should go down to the floor and open as French windows do.

33. Provision should be made for training attendants systematically to their work. They should begin by being taught to nurse the sick, this being an essential part of their work, and tending to produce at once that humanized, softened, helpful frame of mind, with a tendency to regard the patient as an object of sympathy, study, and help, which is of the last importance in a good attendant. The attendant, after being three months in the infirmary ward, should then be sent to the ward for acute cases, and should at first have the charge of only one case, for whom he is to be held strictly responsible. Therefore rooms must be provided for two "probationer" attendants.

34. Nearly all bedrooms should have shutters, with means of ventilation at top and bottom, opposite the openings of windows in summer.

35. It must be recognized as a fact, that the general public have ideas of repulsion and horror of asylums for the insane, those ideas finding their acme in nervous persons of unstable mental equilibrium, who have an undercurrent of consciousness that they may become insane some day. There are many causes for those ideas: e. g., the undoubtedly repulsive nature of some forms of insanity; the terrible pictures of it drawn by the classical and modern dramatists and artists; the inhumane treatment of former times; but, in addition to these, the prison-like character of some asylums, outside and in, has increased this feeling. It should therefore be a pressing duty of every modern asylum architect and physician to counteract this prejudice by making asylum buildings bright, airy, and broken-up looking. A terrible amount of mental suffering might be avoided, were asylums regarded as ordinary hospitals are. To run even to extremes, with this view, may have a good effect in the end.

36. For practical purposes, I think the best classification of one hundred patients into wards is the following. The num-

bers are those which I have ascertained to exist in this asylum for each hundred.

1. Acutely excited, the very demented and dirty in habits . . . 16
2. Recent admissions, improving cases, with some mildly demented, but needing much supervision 20
3. Sick, infirm, paralyzed, epileptics taking very frequent fits, bedridden, very old, and recently admitted cases in a very weak state; all requiring "nursing" 21
4. Convalescent, mildly demented, harmless, and agreeable delusional cases 18
5. Permanent inmates who are delusional, mildly demented, or slightly excited; all useful workers 25

100

37. For each of these classes I would have a ward in the form of a distinct block of buildings, of special construction and arrangement, except that class 1 would occupy the ground floor, and class 2 the first story, of the block A, B, and C (in plan), next the medical officers' quarters. The others I should connect to the centre, and to each other, by glass-covered, winter-garden passages of different lengths, except class 5.

38. The advantages of such an arrangement seem to me to be: *a.* That it best fulfils the principle I have laid down, of making special structural and other arrangements to suit persons in different states of mind. *b.* That while doing so it gives sufficient concentration for administrative, medical, and daily working arrangements. *c.* That there is apt to be a great *esprit de corps*, and also a healthy rivalry, among the chief attendants when they have a "house" to themselves, under their special charge. *d.* That it gives more cheerful and homelike, better-lighted, and better-ventilated rooms. *e.* That thereby the asylum is less "institution" like, and more homelike, its inner life less formal and restrictive through being more varied and natural.

39. The proportion of single bedrooms to associated dormitories has hitherto varied much in different asylums, according to the social classes of the patients, and the ide prevalent on the subject in different countries. In Ameri I am aware, the principle and practice have hitherto b strongly in favor of nearly all the sleeping-accommodat being in the form of single bedrooms. I am myself gre

in favor of a considerable proportion of associated dormitories, because I think they have certain clear advantages, e.g.: *a.* There is better supervision of the patients in them. *b.* There is less risk of suicide. *c.* After a little, many patients like it better. *d.* It checks bad habits at night. *e.* Patients in dormitories exercise much more self-control, as regards making noise, &c. The public opinion of the room is brought to bear on them. If our Scotch plan of making most of the attendants sleep in them with the patients is adopted, most of those advantages are increased. Acting on those views, I have introduced some dormitories, suitably furnished and fitted up for the highest class of patients, in the "East House" at Morningside, where none had previously existed, with very good results. I think the proportion I have provided in the plan, of forty per cent of single bedrooms, is ample in any country. It is more than is needed here.

40. A dormitory for very suicidal patients, with a fireplace in it, where an attendant can sit up all night, and one or two single rooms opening into it for patients who may be very restless or dangerous, is the very best plan yet adopted for preventing suicides during the night. Every asylum should have such an arrangement, though in an institution for two hundred it need not be always in active use.

41. Every ward and block of the institution should be connected to the porter's room, and his room to the physician-superintendent's residence, by electric bells and telephones; while the wards for the acute cases (A), for the sick (E), and for the convalescent (C), in each department should be connected, in the same way, to the chief attendant's room in the admission-ward (B). The porter's room being just under the assistant medical officer's room, he can at once communicate any message to that gentleman. We have had telephones in use here for more than a year, and find them invaluable.

42. Every arrangement in an asylum should combine the greatest amount of simplicity with the greatest amount of strength and durability and good workmanship. Especially does this apply to all the plumber and engineer work, to the water-closets, door-locks, hinges, &c. We use here a much simplified closet, on the "Jennings" principle, which works admirably, and almost never goes wrong.

43. It is not my intention to enter here systematically into asylum management, except to say that the management of an asylum is necessarily much affected by its construction. Without saying that an institution badly built and arranged cannot be well managed, yet I do say that a homelike, cheerful, broken-up asylum is far more apt to be managed on principles that are pleasant to its patients. I have had experience of this. I have seen the mere alteration and reconstruction and re-decoration of a ward produce a revolution in its management, even with the very same attendants in charge of it all the time.

44. A certain number of cottages for the married attendants and officials (say four or five for an asylum of this size) should be built on the outskirts of the property; and each cottage should have one large spare room where one or two patients can be "boarded out," living with and forming a part of the family, who, in money and the patients' labor, receive remuneration and help sufficient to make it an object to wish to have such patients; thus adopting, to this small extent, the true "Gheel principle."

DESCRIPTION OF THE VARIOUS PARTS OF THE ASYLUM.

I shall not attempt a technical or even a minute description of the asylum whose plans are annexed. I shall merely state the principles on which each part is constructed to adapt it for the purposes it is intended to serve, with only enough reference to details to accomplish this object, and to enable the reader to understand the plans. These plans were drawn out in line by me, and were then put in their present shape by Mr. W. Lambie Moffatt of Edinburgh, of Messrs. Moffatt & Aitken, the present architect of the Royal Edinburgh Asylum, who has also been the architect of several asylums both in Scotland and England. To him I am indebted for many valuable suggestions as to details and technical matters.

The Block containing the two Wards for, first, the acute cases; second, the admission improving cases; and, third, the sleeping accommodation in the third story (A, B, *and* C).

These form one block of building of three stories. It is placed next the central administration block, because the

patients in those wards need medical attention, care, and study, far more than any other class. They need more supervision too; and their attendants require to be supervised and kept far more on the alert than those of any other class in the asylum. The objections to going far to meals, &c., apply to this class, rather than to any other. And, as a certain number of patients in the acute ward cannot go to a common dining-room without disturbing its quiet and good order, it is desirable that one of its parlors that can be used as a dining-room should be near the kitchen (A 2).

The block is turned at an angle of sixty-seven and a half degrees to the line of the administration, dining-room, kitchen, &c. This may seem a preposterous thing from an architectural point of view; but my reasons for so placing it were, 1st, To give it an uninterrupted outlook from the chief day-room and corridor windows. 2d, To avoid looking down at the great block of building forming the kitchen, scullery, and workshops. In these respects, both cheerfulness and the feeling of privacy are secured, and a greater *individualization* of each ward as a distinct entity, and not being merely a bit of a large institution.

The Ward for the acute cases, and some of the very demented, who are dirty or slovenly—ground floor; for sixteen (A).

This consists of two parlors (2 and 8), each with distinctive features, and a corridor between. In this way the patients for whom the ward is intended can be classified and segregated according to their condition at the time, and one or two acutely maniacal cases could be treated without necessarily disturbing all the others. The parlor (2) is within eighty feet of the dining-room, and eighty-five feet of the kitchen, and is intended also as the dining-room of those patients who cannot go to the central great dining-room. The other parlor (8) is very well lighted, cheerful, and with two aspects. It is intended for the more quiet cases. The corridor is large enough to sit in, as well as afford a good long promenade for an excited patient, and has two recesses (4 and 6) for seats for about four or five patients. There should usually be four or five patients in the one parlor (2), seven or eight in the other (8), and four or five in the corridor. Three attendants should take charge of the ward at

almost any time, and two (one in each parlor) when there were no specially excited cases in it. Of course, four or five might be needed at times, when individual cases needed special attendants.

Each patient has a hundred and twenty-five superficial feet of day-room floor-space in this ward. This is the largest allowance in any part of the asylum, as such patients need it most. Space tends to quietude, and freedom from irritation and contact with the other patients.

The other accommodations provided by the ward are seven bedrooms (5) for the more quiet patients,—one being for an attendant,—and an annex thrown back at a right angle, containing a back staircase (9) and three bedrooms (10) for noisy or very violent patients; this annex being shut off from the rest of the ward by double doors and thick walls for preventing the noise made by patients in those rooms disturbing the others. The aspect of those rooms is away from that of the others, for the same reason.

One of those rooms should be a "padded room," lined for five feet above the floor and over the floor itself with strong shoe-sole leather, cut in large pieces, five feet by two and a half feet, each piece being sewed to the next at the edges, and then well screwed to the wall on two folds of thick felt. Above this, the room should be lined with wood. The surface of the leather should then be neatly stencilled, and coated with four coats of the best varnish. It is then soft, impervious to urine, strong, and makes a pleasant-looking room, just like an old library hung with stamped leather. In this way the forbidding features of an ordinary "padded room" on the patient's mind are avoided. There should be a gas-light in the centre of the room, or above the door, protected by a light wire grating; and a small inspection-hole in the door.

The other two rooms (as also all the rooms in this annex in the second and third stories) should be either finished in smooth strong cement, well painted, and tastefully stencilled in bright colors, with close narrow-tongued, well-seasoned, hard-wood floors, well varnished; or the walls for six feet high can be framed and panelled in well-seasoned oak, this being screwed on some soft material like roofing-felt, to deaden the sound if a patient tries to drum on it with his fists. We have

four such rooms in the "East House," Morningside, that are as "strong rooms" as are ever required, and yet look quite like an old English oak room. If a patient is maniacal, the furniture is taken out: when he gets more quiet, it is put back; and with this, and a bright carpet-rug on the floor, such a room looks quite attractive, — a great matter to attain for the most special and asylum-like part of such an institution.

All the doors, shutters, hinges, woodwork, &c., of these nine rooms in the three floors of this annex, should be made very strong and substantial. The short corridor to the rooms (11) opens by a door into the glass corridor leading to the convalescent-block. This might be convenient for taking an excited patient through for exercise in the "winter-garden" in bad weather, and in other ways.

There is a lavatory and bath-room (12), with a bath and shower for medical and special purposes; and opening out of this into a projecting tower (7) on the back of the building are the water-closets, slop-sinks, and, in the wards for men, urinals. There are windows and extracting ventilators on each side of the tower on each story; and the door opening from the lavatory to them should have a spring to keep it always shut, and should shut on an India-rubber tube, so that there shall be no chance of sewer-gas or bad smells from the closets entering the wards. The water-closet tower might easily be made a very ornamental feature of the building architecturally, and should be carried above the roof of the block.

The Ward for the newly-admitted cases, the moderately excitable, the improving, and a few chronic cases that need special attention or care; for twenty (B).

This ward is the same as the last in structure, being above it on the second floor, all the partition-walls being carried up. It is intended for twenty patients, who will thus each have one hundred superficial feet of day-room floor space. Such patients don't need so much space as those in the acute ward, though they need a good deal. It is intended that they all should go to the central dining-room to meals, with perhaps occasional exceptions in the case of temporarily excited patients, who would dine in the parlor (2) of the *acute* ward.

All the rooms, day-rooms and bedrooms, should be painted in most cheerful, tasteful colors, the furniture and fittings should be extra good, and the supervision should be very thorough. The head attendant should occupy one of the bedrooms in this ward, and the attendant in charge of it should be the best in the house. The "first impressions" of the newly-admitted patient should be pleasant. He should get the impression that every thing is well-ordered, homelike, and comfortable, and that great attention is paid to the study of his symptoms. There is nothing that takes off the irritation of a patient's forcible removal from home, like the conviction that he has come to a hospital where he is to be medically examined and treated, and where every thing is done that is possible for him. A physician should spend at least the first half-hour he is in the asylum with him in the ward, examining him, and taking notes as to his symptoms. Such an examination interests and amuses him, distracts his mind from the unpleasantness of being taken from home, and exalts his self-importance; while, to the physician, the knowledge of the case thus acquired is simply invaluable, and is never forgotten. The patient and doctor often in that way learn to understand each other, and this understanding is all-important. This ward is in immediate contiguity with the billiard and amusement room; and one of its parlors should be fitted up, and used as the general library.

The Sleeping Accommodation for some of the patients and also some of the attendants from both the admission and the acute ward, and the suicidal dormitory (C).

This is on the third story; and, if economy or architecture demands, it can be constructed with a French roof (double, to protect from the heat of summer and the cold of winter). It consists of dormitories (2, 5, 8, 10, 11) and single rooms (4, 9, 13), more than sufficient for the population, sane and insane, of the two wards below it that cannot be accommodated in the twenty single sleeping-rooms in those wards. If those wards were fully occupied, there would be nineteen patients and four or more attendants that would sleep there. The night attendants could have rooms up here too. It is intended that the rooms in this story should be occupied only during the night; the patients and their

attendants going down to one or other of the two wards below when they have washed and dressed in the morning.

Seven patients and one attendant could sleep in the dormitory marked 2, five and one attendant in 8, one in 5, one in each of the three marked 9, while room 10 could be used as a special suicidal dormitory, with 11 occupied by a patient both suicidal and dangerous, or very restless. A large lavatory, 6, is provided here. Rooms 13 are for noisy or restless patients.

In most of the modern English asylums there are upper stories used in this way, for sleeping-rooms only, and it works well. I have myself had experience of it, and like it. Much extra accommodation is thus got at small cost. If preferred, wooden screens four or five or six feet high could be erected between the beds, as in some of the English public schools, thus securing more privacy, and not interfering with the other good effects of a dormitory, or with the ventilation of the room.

The Ward for convalescents and also some chronic cases whose mental state is liable to change; for eighteen (D).

This ward consists of a one-story block, of simple construction, connected to the dining-room by a glass-covered way that takes a circular course up to the acute-ward A (20), ten feet wide, and four hundred and eighty feet long,— a part of the winter-garden. The block is so placed, that it interferes with the views from the admission and acute wards (A and B) as little as possible; and this is one of the objects of its being one-storied. It is an oblong building seventy-five feet by fifty, with projections (3, 7, 9, 18) at the corners which are used for water-closets and lavatories at the back (9 and 18), and as pleasant bow-windows off the two parlors in front (3 and 7). It has a veranda round three sides of it (19).

It consists of a corridor ten feet wide (1) down the middle, off which open all the chief rooms. This corridor is well lighted and ventilated from the roof all along its length, and has two recesses with seats, and two fireplaces. There are two parlors (4 and 6), the one large enough for a billiard-table (6), and used as the smoking-room in the case of the male ward, and as a work-room in the case of

the female ward; while the other (4) is to be used as a reading and non-smoking room. These two rooms should be "got up" quite differently from each other, and also from the corridor. It is difficult often to get architects and painters to take the trouble to exert their ingenuity to get varied effects in the different rooms of an asylum; but this is very important, and should be done. It costs little more than unbroken monotony of color and effect. Both parlors open into the verandas, and double doors should be provided for winter.

All the sleeping accommodation is in the form of dormitories, which may have low wooden screens between each bed (5, 8, 13, 16); and each patient is allowed fifty-six superficial feet of day-room floor space, and seven hundred and forty-seven cubic feet of air by night. Stores are provided (12 and 15), and also attendants' rooms (11 and 15). It will be at once seen that the whole effect of this building, inside and out, is different from the acute and admission block, and the *feeling* of living in it quite different. It is more simple, homelike, and, being all on the ground-floor, more cottage-like, and less formal and hospital-like. We have at this asylum two wards built somewhat on this principle, that work admirably.

All the patients of course come to the dining-room for their meals, and the distance is not nearly so great as from some of the rooms to the *tables d'hôte* of some hotels. They are all expected to employ themselves in some way. The unity of administration is kept up by having this ward connected to the administrative block by telephones. The patients in this department may be regarded as coming after those in the sick-ward and before those in the cottage, as regards the necessity for frequent medical supervision and attention. They come fourth of the five classes in this respect.

The Ward for the sick, paralyzed, very weak, very old, bedridden, blind, the recent cases especially of melancholia that are very weak, and the class of cases generally that need nursing; for twenty-one (E).

A mere glance at the list of the different classes of cases that are to inhabit this ward shows that we must provide

suitable special accommodation for them, that this accommodation must be all on the ground-floor, that it had better be apart from the rest of the asylum, and yet not too far from either the central kitchen or the medical officers' quarters. The patients cannot go to the central dining-room for their meals: so a dining-room must be provided (5). A certain amount of minor cooking, and keeping beef-tea, &c., hot, must be done too: therefore it must contain a small kitchen. As a man and his wife are intended to have the chief charge of this ward, a kitchen adds much to the element of domesticity. Among the patients in the sick-ward of an asylum, some had better sleep in dormitories, others in single rooms. Some of the former require to be in bed all day, others only a part of it, and others can be up all day. The greatest variety, too, exists among the patients who need to sleep in single rooms. There is an enormous difference between the general paralytic in the end of the second stage of his disease, who is restless and noisy at night, though so weak that he stumbles and falls about his room, very dirty in his habits, rubbing his fæces over the walls of his room, unable to feed or clean or dress himself, and the quiet, slightly demented, consumptive or hemiplegic patient, who needs to be in bed all day, but whose cough or helplessness would disturb the others in a dormitory. Both of those need single bedrooms; but it would be undesirable, if it could be avoided, to place them next each other. I have never yet seen a sick ward whose construction and arrangements seemed to me so varied as the requirements of its patients.

The building I have planned is a separate one-story block (E), three hundred and forty feet from the central kitchen, connected by a prolongation of the winter-garden corridor (17). It consists of a central corridor (1), roof-lighted, ten feet wide, into which open on the back of the building, on entering it from the corridor (H), two storerooms (2 and 3), one for brushes, pails, &c., and the other for linen and clothes. Then comes the kitchen, with a small cooking-range and the means of washing and storing dishes. If the dinners are cooled in coming along the corridor from the great kitchen, they can be easily warmed here; and as the serving of the meals to so many helpless people takes a considerable time, from many of them having to be fed, the meals of

those last served can be kept hot. Here the wife of the attendant in charge presides; she is the "housewife," and makes the breakfasts and teas, assisted by a quiet female patient; the dinners coming from the central kitchen.

Opening out of the kitchen, and occupying almost the centre of the building, is the dining-room (5), with sufficient space, tables, and chairs, to dine fourteen, or two-thirds of the patients, in the ward. I find that proportion sufficient here. The others are in bed, or too helpless to come to table. The dining-room walls should be carried up five feet above the height of the ordinary walls of the sick-room, to form a central hall, and to give ventilation; and it should have a large cupola-light with a ventilator in the centre of the ceiling, which should be more or less dome-shaped. In that way all the "dinner smell" is carried up and away, without permeating the rest of the ward.

Opening out of the dining-room, there are two small dormitories for three patients each (16), which are to be occupied by quiet bedridden people. Their meals can be served very conveniently from one of the dining-room tables.

From the back of the dining-room opens a short corridor with double glass door at the end (for taking bodies to the dead-house) (10), which is the centre of a projecting annex, that contains four single bedrooms for patients who are noisy at night, an attendant's (probationer) room (7), and a small bath-room and water-closet for the helpless, dirty, and paralyzed, who may occupy those four rooms (9). Those rooms are so placed that noise in them is not heard by many of the patients in the rest of the ward. This annex should be shut off by thick walls and double doors from the rest of the ward; and every room should be well heated by steam-pipes, and not have open fireplaces, as such patients sometimes throw off their bedding, and roll about their rooms naked.

On the other or front side of the corridor, there are, first, three single bedrooms (10) with a sunny aspect, for quiet, cleanly, more sensible patients, suffering from bodily ailments, or for newly-admitted patients, who may be very weak, and need much nursing. Those rooms are so convenient to the kitchen (14), that meals can be served in them very easily. Next to them on the same side of the corridor there is a large dormitory-dayroom for patients who may keep their beds

part of the day. It has a fireplace and bow-window; one corner of the room being kept free of beds, and used as a place where patients can sit when they get up. The eight beds are placed round the rest of the room. Such a room, cheerfully painted and well furnished, I look on as a most necessary part of any asylum infirmary-ward.

Next it, still on the same side of the corridor, is the room for the married couple who have charge of the ward (12). Still farther along is the day-room proper, for those patients who are able to be up all day. It has two good exposures, a bow-window, and opens into the corridor, and also into the veranda (16).

The larger bath-room, and lavatories and water-closets for general use (14 and 15), project out from the building, have cross-ventilation, and are shut off by double doors from the corridor.

Over three thousand cubic feet of air-space is allowed in this ward per patient in day and night rooms together. This large amount is needed for this class of patients.

Every thing in the sick-ward should be bright, airy, and cheerful. No paper should be used on the walls; all the color being got by paint, which should have a final coat of fine varnish. Every room, almost, should have a different tint of wall. The floors should all be hard wood, or pitch-pine well-seasoned, and sawn into narrow boards, and tongued.

The Detached House, for chronic, useful, slightly enfeebled, and more slightly-crazed patients, none of whom require active medical treatment or constant supervision; for twenty-five (F).

This house may be placed in any convenient situation; but probably the best place for it would be somewhere near its position in the block plan, as being least obstructive of the views from the rest of the building. It is a two-story house simple and homelike in character, and could be built of brick, stone, or wood. If any moderate extensions of the asylum were needed through the filling-up of the other wards with quiet incurable cases, a number of such houses could be built in different parts of the grounds. It is intended that the patients from this house should come to their meals in

the central dining-room; and in bad weather they could come so far along the glass corridor to the convalescent-ward. This should be kept in mind in fixing the position of the house.

On the ground-floor there are two day-rooms (1 and 4) of different forms and aspects, that should be painted and furnished differently, to give variety. There is a front door (2) with outer porch and hall (3), to which runs at a right angle a passage leading to five single bedrooms (one being for an attendant), and a storeroom (8). At the end of the main hall, opposite the front door, is the stair, leading to the second story (6); a passage by the side of this stair, and going under the first landing, leads to bath, lavatory, and water-closets, which project so as to secure cross-ventilation. Behind one day-room (4) there is a small room (5) for a combined kitchen, scullery, and attendant's dining-room.

On the second floor the same rooms exist; but those over the parlors are dormitories, and an attendant's room is taken over the front hall, opening into both dormitories. Two attendants are sufficient for twenty-five of this class of patients, and even one efficient, experienced attendant might take charge of them. A house of this kind for men should have a man and his wife in charge as attendants. This works well in such detached houses at the Cupar, Wakefield, Cheadle, and other asylums in England.

Each patient has forty-two superficial feet of day-room floor-space, and nine hundred cubic feet of air-space in the dormitories, and twelve hundred feet in the single bedrooms. This is a very great allowance for such a class of patients, who ought to be much out in the farm, winter-garden, or workshops; and, if economy were much of an object in building an asylum, from thirty to thirty-five patients might be put into such a house, or it might be made of less size for the twenty-five.

It may strike some one, why so many single bedrooms should be provided in this house, and none in the convalescent-block. The reason I have done so is that I think it is better, on medical grounds, for the convalescent patients to sleep in small dormitories, while, living in such a house as this, there would be many chronic cases whose only home it is for life; and I would let a few such, who were specially

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useful to the place, have single bedrooms as a reward and encouragement; and in those rooms I should allow such patients to collect their *Lares* and *Penates*,—homelike trifles or foolish accumulations, as the case might be,—at all events, I should let such people have in a very full degree the sweet sense of possession of a room and all that it contained.

All the patients in this house would be in good bodily health, and so would be able to go to meals, prayers, chapel, and workshops. In fine weather they would probably all go straight across to the workshops and dining-rooms, rather than so far by the covered corridors. I have had experience of such houses for men and women, and I know they work well if the patients are properly selected.

The Administration Block (G).

This is not very special in its character. It simply consists of a large house of four stories, with rooms (as marked on plan) suitable for porter, visitors, assistant medical officer, matron, household and kitchen servants' bedrooms. As the architectural centre of the building, it is better to have it of four stories; and an able architect could here exert his ingenuity and taste to the utmost.

The Glass Corridors of Communication and Winter-Gardens (H).

At the front door in this block begins the corridor (H), that leads everywhere to the different parts of the asylum, except the detached houses. This hall should be spacious, wide, and inviting. It leads straight to the front of the dining-room, and is formed chiefly of glass from where it leaves the back of the administration block, throughout its length and ramifications. It is to be filled with plants and flowers; and the colors of its timbers, &c., are to be bright and harmonious. On each side, to fill up the lower part of the spaces between the dining-room and administration block, there are two conservatories (H). Thus a patient, or his relative coming to see him, as he passes for the first time along the corridors to the wards, sees nothing gloomy or prison-like, but, on the contrary, has a distinct feeling of cheerful brightness. I cannot sufficiently reiterate, that such

a passage of communication to the asylum has a good effect psychologically on the patient. The whole system of combined glass corridors of communication, and winter-garden, I consider one of the most important and novel in this asylum plan. It combines utility and beauty in the highest degree.

The Dining-Room (I).

This is a large room, fifty-two feet long by thirty wide, and twenty in height. It is peculiar in its construction. It has really two walls; the outer, of glass, being the wall of the glass corridor (H), while its inner wall is constructed of brick piers to carry the roof, with the spaces between partly formed of lath-and-plaster partitions, and partly of large glass doors or glass screens. The impression produced by such a room is that of being in an arcade with a conservatory outside it.

There are two chief entrances for patients: one near the front, for those from the convalescent and detached houses; and one near the other end, for those from the admission and acute wards. A dining-room of this construction, tastefully colored, is most cheerful and very comfortable both in summer and winter. The layer of slightly-warmed air that really forms its wall is about the very best material for that purpose. We have two such rooms here in the Royal Edinburgh Asylum, and they are admitted, by all who have seen them in use, to be perhaps the most beautiful, cheerful, comfortable, and unique dining-rooms in any British asylum.

The Amusement-Room and Billiard-Rooms (over I).

These occupy the floor above the dining-room, and to gether are the same in size, shape, and construction. Their walls are formed in the same way as those of the dining-room, the glass corridor (H) being here carried up for two stories. This is the only place where this corridor exceeds ten feet high. It can be here made forty feet high, either in wood or iron, with the brick piers of the dining-room and drawing-room walls as the solid basis of support.

The amusement and combined billiard and news rooms should have a different character, and should open *en suite* for specially festive occasions by large sliding double doors.

There should be a stage at one end of the amusement-room, for the performers in concerts, plays, &c. The billiard-room should not have so much side-light, and more roof-light. It should be used as a general news and reading room, with newspapers, maps, books of reference, atlases, dictionaries, &c., lying about.

The Kitchen and Scullery (K *and* L).

The kitchen is an oblong room lighted from the walls above the glass corridor on each side, and especially from the roof, thirty feet by twenty-eight by twenty-five in height, with all the steam-cooking boilers together in the centre of the room, and a large cooking-range next the scullery. The walls should be lined with white glazed tiles for at least six feet high, and above that should be finished in smooth cement. There are two large service openings from the kitchen into the dining-room.

The scullery is a room thirty feet by twenty, properly fitted up with sinks, plate-racks, presses, &c.

The Kitchen Court (M), *Steward's Department* (N), *Boilers, Coal-House, Bake-House, Surgery, &c.* (O).

Beyond the scullery the glass winter-garden corridor is carried across at a right angle to that part of it which has run alongside of the kitchen and scullery. In this way free communication is got across from one side of the house to the other; e.g., for the linen to be taken from the male wards, to and from the laundry (U); for the men going to the bath-house (T); for the women to take articles to be repaired in the work-shops (P H). There is a large kitchen court (M) beyond the corridor, into which the road for supplies, &c. (V), enters. One side of this court is a block of building (N), containing the steward's and general store-room, his office, stores for potatoes, coals, beer, &c. The glass corridor thus runs angularly round the corner of this, and then in a straight course parallel to the entrance-road up to sick-ward (E). Of course the steward's stores and office open into it, as well as into the kitchen court. It gives a unity to the whole administration of the institution.

On the other side of the court is a block of building containing larder, milk and flour store, bakery, surgery, and

surgical-instrument room. One set of those open into the court; the other, into the corridor on the outside of the block.

The Workshops (P).

These are all made easily accessible by the glass corridor (H), and consist of engineer's, plumber's, carpenter's and cabinet-maker's, upholsterer's, shoemaker's, and tailor's work-rooms, — all well lighted from walls and roof, and cheerful, healthy, well-ventilated rooms, whose inside walls are all done in bright, cheerful colors. The number of patients in them at any one time will vary, but together they should be capable of accommodating twenty men at work.

The Gymnasium, and the Workroom for the idlers, loafers, and amateur artificers who make crazy, useless articles (R).

This forms a block on the other side of the glass corridor from the workshops. The gymnasium is a lofty, airy room, with most of the appliances used in an ordinary gymnasium, except that the principle of safety is more thought of.

The idlers' and amateurs' workshop I look on as a great institution. Many people about an asylum will go there most usefully to themselves, who won't go into the regular shops; and there are others who would go to the latter, but would merely hinder the real useful workers.

The Dead-House, Post-mortem Room, Necroscope Room, small Chemical Laboratory, and Pathological Museum on the second story (S).

This forms a block by itself; the dead-house opening into the road, and the necroscope room opening into the corridor (H). I have placed it in this position for the convenience of the medical officers. In many respects it would be better to have a dead-house a detached building near the outer gate. But it is apt to cool pathological research, for the medical officer to have to walk from such a building to his rooms at two o'clock of a winter morning.

The Museum.

This is a well-lighted, oblong room over the microscopic and chemical rooms, thirty feet by fifteen, lighted chiefly from the roof, and suitably fitted up.

The mere fact of having rooms there, suitable and ready with all the appliances, stimulates and encourages the medical officers (or outsiders with pathological tastes) to original investigation and research.

Forty feet beyond this block the corridor leads to, and ends in, the male sick ward (E).

The Bath-House (T).

This consists of an ordinary bath-room with movable screens between each bath, a swimming bath, a Turkish bath, a complete set of medical baths, and a dressing-room. It is a most important adjunct to an asylum, for medical and hygienic reasons.

The Laundry (U).

This enters from the glass corridor, on the female side, by a wide entrance. It consists of receiving and distributing rooms, wash-house, laundry, drying-closet, and engine-house for a small steam-engine to work the machines.

The Road of Entrance (V),

for the delivery of all stores and for all non-medical business traffic

The Chapel (W).

This should be built to contain the whole number of patients in case of any future enlargements. It can be connected, if desired, by an offshoot at a right angle of the glass winter-garden corridor, connecting the convalescent block to the centre. The best position is that shown on the block plan, flanking the physician's house. Standing thus apart, the patients have the feeling of "going to church" on Sundays.

The Physician-Superintendent's House (Y).

This should be a quite separate building, of villa character, in its own enclosed garden. It can be connected by an extension of the glass corridor similar to that leading to the chapel, if desired, or if the climate demands such an arrangement.

In conclusion, this asylum may be called a "hospital

home" for the insane, planned in its various parts on the principle of adaptation of each house to the mental state of its inhabitant. If, in practice, I have failed thoroughly to harmonize construction with all the varied phases and needs of mind diseased, I am certain that the principle I have adopted is the right one. I have had in view cure more than care in devising these plans. I think this Hospital-Home would be found suitable for the treatment of an unusually large number of recent cases, in proportion to the whole number of the inmates. One hundred patients a year might be sent to it, provided the quiet and improved cases, as well as the recovered, were discharged. The theory on which it is constructed would be quite upset, were it to become chiefly a comfortable residence for incurable cases. And while I cannot point to the success or otherwise of an institution where the principles of adaptive construction I have endeavored to lay down have been fully carried out, because in my opinion none such exists, yet I am able to refer to five years' experience of increasing quietude and contentment, diminished excitement and liability to accidents, a smaller death-rate, and a higher percentage of recovery, among my patients here, since extensive additions and reconstructions in an old building have been carried out under my own eye, on these principles.

THE VARIOUS PORTIONS OF THE ASYLUM.

(See accompanying plan.)

THE SCALE SHOWS THE SIZES OF THE VARIOUS ROOMS.

A.	Ward for acute cases, &c.	These in one three-story block.
B.	Ward for admission-cases, &c.	
C.	Sleeping-accommodation for some of the above two classes and their attendants. A suicidal dormitory, &c., in the third story.	
D.	Block for convalescents. Connected by glass corridor.	One story.
E.	Sick ward. Connected by glass corridor.	One story.
F.	House for quiet chronic workers.	Detached; two stories.
G.	Administration block.	Four stories.
H.	Glass corridor of general communication, also used as winter-garden, promenade, smoking-corridor, exercise-place for excited cases, &c.	Ten feet wide, by eight or ten feet high.
I.	Common dining-room, with amusement-room and billiard-room over it, all with conservatory walls.	
K.	Kitchen.	
L.	Scullery.	
M.	Kitchen court.	
N.	Steward's department, stores, &c.	
O.	Surgery, &c.	
P.	Workshops.	
R.	Gymnasium and idlers' workshop.	
S.	Dead-house, post-mortem room, microscopic and chemical rooms, and pathological museum.	
T.	Bath-house.	
U.	Laundry.	
V.	Road of entrance for stores, &c.	
W.	Chapel.	
Y.	Physician-superintendent's residence.	

THE GROWTH OF CHILDREN.

(A SUPPLEMENTARY INVESTIGATION.)

WITH SUGGESTIONS IN REGARD TO METHODS OF RESEARCH.

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THE GROWTH OF CHILDREN.

(A SUPPLEMENTARY INVESTIGATION.)

The Relative Importance of Mode of Life, and of Race, in determining the Size of Growing Children.

In an article on "The Growth of Children," published in the Eighth Annual Report of the State Board of Health, it was shown that in the public schools of Boston, children of American parentage are taller and heavier than children of the same age of Irish parentage. Reasons were also given for believing that this difference depends in part upon the greater degree of comfort which prevails in the homes of the former class of children, and in part upon differences of race or stock. The question of the relative importance of these agencies in bringing about the result was left undecided. An attempt has now been made to throw light upon the subject by tabulating the observations for each nationality, according to the *occupation of the parents*, as given in the records of the schools, and comparing together the averages of the various classes thus formed. The result of this additional study of the original data is given in the following pages.

The object being to ascertain whether differences of race or differences in the mode of life affect the rate of growth the more profoundly, it was important so to classify the observations that the occupations thrown together into a common class should be those of persons enjoying in about equal degree the comforts and luxuries of life. A perfectly unobjectionable classification of this sort, it is, of course, impossible to make, since persons described as following the same occupation may often have very different social positions. The term "paper-maker," for instance, may designate either the wealthy owner of numerous paper-mills, or one of the poorest of his employees.

The classification employed by Dr. Baxter[1] in his study of the effect of occupation on the liability to disease, seems, upon the whole, convenient and practical; and it has therefore been adopted, in its essential features, in this investigation.

The following table shows this writer's classification of occupations into four groups; viz., professional, mercantile, skilled, and unskilled labor. The second division of each group consists of occupations which are not mentioned in Dr. Baxter's classification, but which, being represented in the records of the Boston schools, have been assigned to the various classes as shown in the table.

TABLE No. 1.—*Showing Dr. Baxter's Classification of Occupations.*

PROFESSIONAL.	MERCANTILE.	SKILLED LABOR.		UNSKILLED LABOR.
1 Architects.	1 Agents.	1 Bakers.	26 Paper makers and hangers.	1 Barkeepers.
2 Clergymen.	2 Brokers.	2 Barbers.	27 Photographers	2 Boatmen.
3 Dentists.	3 Clerks.	3 Blacksmiths.	28 Plasterers.	3 Carters and drivers.
4 Druggists.	4 Grocers.	4 Bookbinders.	29 Plumbers.	4 Factory hands.
5 Editors.	5 Inn-keepers.	5 Brickmakers.	30 Printers.	5 Farmers.
6 Lawyers.	6 Liquor dealers.	6 Butchers.	31 Sailmakers.	6 Firemen.
7 Musicians.	7 Merchants.	7 Cabinet makers.	32 Shoemakers.	7 Fishermen.
8 Physicians.	8 Peddlers.	8 Carpenters.	33 Stone cutters.	8 Laborers.
9 Public officers.	9 Tobacconists.	9 Carriage makers.	34 Tailors.	9 Lumbermen.
10 Students.		10 Cooks.	35 Tanners and curriers.	10 Miners.
11 Teachers.	1 Book-keepers.	11 Coppersmiths.	36 Telegraph operators.	11 Ostlers.
	2 Caterers.	12 Distillers.	37 Tinsmiths.	12 Porters.
1 Actors.	3 Collectors.	13 Engineers.	38 Upholsterers.	13 Railroad men.
2 Army or navy officers.	4 Contractors.	14 Engravers.		14 Sailors.
3 Civil engineers.	5 Cotton samplers.	15 Gun and lock smiths.	1 Bridge superintendents.	15 Soldiers.
4 Surveyors.	6 Detectives.	16 Harness makers.	2 Conductors.	16 Servants.
	7 Railroad superintendents.	17 Hatters.	3 Foremen.	17 Watchmen.
	8 Salesmen.	18 Iron workers.	4 Inspectors.	
	9 Sea captains.	19 Jewellers.	5 Letter carriers.	1 Expressmen.
	10 Undertakers.	20 Machinists.	6 Moulders.	2 Jobbers.
	11 Weighers.	21 Manufacturers	7 Packers.	3 Pavers.
		22 Masons.	8 Policemen.	4 Puddlers.
		23 Mechanics.	9 Stable superintendent.	5 Whitewashers.
		24 Millers.		
		25 Painters.		

[1] Statistics, Medical and Anthropological, of the Provost-Marshal-General's Bureau. By J. H. Baxter, A.M., M.D. In two volumes. Washington, 1875.

The original observations furnished by the principals of the schools were tabulated in accordance with this classification, and the average heights and weights calculated for each of the four classes of occupations. The result of this calculation, expressed both in the English and the metric system, is given in tables 2, 3, 4, and 5. It will be noticed that the only nationalities represented in these tables are the American and the Irish. Observations on children of parents of any other single nationality were not found to be numerous enough to warrant a distribution of them in accordance with occupation. All such observations were, however, thrown together into a single group of unclassified nationalities, and the average heights and weights calculated for the various occupations in the same way as for the American and Irish groups; but, since the figures thus obtained did not seem to throw any additional light on the question under consideration, it was not thought desirable to present them in print.

An examination of these tables shows that while in general the children of the professional and mercantile classes are larger than those of the laboring classes, yet no very exact gradation of size, corresponding to grades in the social scale, can be observed. On the contrary, it will be noticed that the children of parents engaged in unskilled labor are not infrequently larger than those whose parents are skilled laborers. This is particularly noticeable in the case of boys of Irish parentage. Here it will be seen, that, at nearly every age at which the observations are sufficiently numerous to justify a conclusion, the weight of the children of unskilled laborers is greater than that of the sons of skilled workmen. This fact is rendered evident by the curves given on Plate I.[1]

Since the number of observations, in many of the groups in these tables, is too small to eliminate from the averages the effect of individual peculiarities, larger groups have been formed by uniting the professional and mercantile occupations into a "non-laboring," and the skilled and unskilled

[1] In this and all the following plates the ordinates of the curves represent the heights and weights corresponding to the various ages expressed on the line of abscissas. The upper curves show, in every instance, heights in inches, as indicated by the column of figures on the left; and the lower curves, weights in pounds, indicated by the column of figures on the right of the plate. The figures at the bottom of the plate show, for each age, the number of observations from which the averages were computed.

TABLE No. 2.—*Showing Average Heights (without shoes) of Boston School Boys.*

PARENTAGE AMERICAN.

AGE AT LAST BIRTHDAY.	Occupation of Parents.											
	PROFESSIONAL.			MERCANTILE.			SKILLED LABOR.			UNSKILLED LABOR.		
	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.
Five . . .	10	42.10	107.0	52	41.91	106.5	88	41.68	105.9	47	41.75	106.1
Six . . .	19	44.41	112.9	100	44.47	113.0	149	44.09	112.0	67	43.44	110.4
Seven . .	31	46.98	119.4	110	46.48	118.1	147	46.05	117.0	71	45.85	116.6
Eight . .	27	49.36	125.4	117	48.34	122.8	166	47.98	121.9	80	47.84	121.6
Nine . .	22	50.59	128.5	108	50.33	127.9	165	50.25	127.7	74	49.70	126.3
Ten . . .	30	52.31	133.0	109	52.36	133.1	138	51.93	132.0	57	52.03	132.2
Eleven . .	33	54.75	139.1	121	54.43	138.3	136	53.88	136.9	49	53.38	135.6
Twelve . .	39	56.68	144.0	126	56.40	143.3	144	55.36	140.6	33	55.01	139.7
Thirteen . .	49	58.81	149.4	121	58.43	148.5	139	57.81	146.9	48	57.89	147.1
Fourteen . .	33	61.26	155.6	148	61.31	155.8	135	60.44	153.6	37	59.92	152.3
Fifteen . .	33	64.40	163.7	126	62.86	159.7	112	62.19	158.0	37	62.66	159.2
Sixteen . .	27	65.10	165.4	92	65.61	166.7	81	65.35	166.1	11	66.94	170.1
Seventeen . .	23	66.56	169.1	47	66.34	168.5	38	65.91	167.5	5	66 22	168.2
Eighteen . .	10	66.92	170.0	27	66.98	170.1	17	66.10	167.9	2	68.45	173.9

TABLE NO. 2. — Continued.

PARENTAGE IRISH.

AGE AT LAST BIRTHDAY.	OCCUPATION OF PARENTS.											
	PROFESSIONAL.			MERCANTILE.			SKILLED LABOR.			UNSKILLED LABOR.		
	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.
Five . . .	1	30.90	78.5	23	41.42	105.8	100	41.58	105.6	285	41.60	105.7
Six . . .	3	42.96	109.2	45	43.64	110.9	158	43.90	111.5	309	43.70	111.1
Seven . .	1	46.60	118.4	40	46.16	117.3	219	45.40	115.4	336	45.66	116.0
Eight . .	1	48.10	122.2	51	47.60	121.0	209	47.66	121.1	329	47.70	121.2
Nine. . .	2	49.77	126.5	46	49.80	126.5	186	49.70	126.3	306	49.58	125.9
Ten . . .	1	51.90	131 8	43	51.78	131.5	181	51 06	129.7	323	51.83	131.7
Eleven . .	2	52.–	132.1	43	53.40	135.7	195	53.03	134.7	285	53.08	134.9
Twelve . .	2	54.45	138.4	35	55.61	141.3	161	54.65	138.9	281	54.80	139.2
Thirteen . .	1	62.60	159.1	29	57.62	146.4	147	56.52	143.6	249	56.64	144.0
Fourteen . .	3	57.90	147.1	33	58.40	148.4	103	58.99	149.8	176	58.55	148.8
Fifteen . .	1	60.10	152.7	17	60.47	153.6	58	61.08	155.2	74	61.54	156.4
Sixteen . .	–	–	–	14	65.23	165.7	28	63.10	160.3	20	64.32	163.5
Seventeen . .	–	–	–	6	65.–	165.2	8	66.56	169.1	10	66.13	168.0
Eighteen . .	–	–	–	3	68.03	172.8	1	68.10	173.0	1	66.40	168.7

TABLE NO. 3. — *Showing Average Weights (in ordinary dress) of Boston School Boys.*

PARENTAGE AMERICAN.

AGE AT LAST BIRTHDAY.	OCCUPATION OF PARENTS.											
	PROFESSIONAL.			MERCANTILE.			SKILLED LABOR.			UNSKILLED LABOR.		
	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.
Five . . .	10	41.97	19.04	52	41.33	18.75	88	40.68	18.45	47	41.35	18.76
Six . . .	19	44.63	20.24	100	45.79	20.77	149	45.14	20.47	67	44.09	20.00
Seven . .	31	50.82	23.05	110	49.76	22.57	147	48.91	22.19	71	49.47	22.44
Eight . .	27	56.51	25.63	117	54.56	24.75	166	53.40	24.22	80	54.83	24.87
Nine . .	22	62.54	28.37	108	60.80	27.58	165	60.08	27.25	74	59.19	26.85
Ten . . .	30	65.71	29.80	109	66.15	30.00	138	65.96	29.92	57	67.39	30.56
Eleven . .	33	74.87	33.96	121	73.09	33.15	136	71.81	32.57	49	71.76	32.55
Twelve . .	39	83.93	38.07	126	82.08	37.20	144	77.54	35.17	33	77.40	35.10
Thirteen . .	49	90.76	41.16	121	90.03	40.83	139	85.85	38.94	48	89.15	40.48
Fourteen . .	33	101.94	46.24	148	99.15	44.97	135	98.69	44.76	37	96.64	43.83
Fifteen . .	33	109.94	49.86	126	110.75	50.23	112	109.41	49.62	37	103.74	47.05
Sixteen . .	27	123.02	55.79	92	124.06	56.27	81	121.10	54.92	11	135.57	61.49
Seventeen . .	23	129.37	58.67	47	129.12	58.56	38	128.56	58.31	5	129.04	58.52
Eighteen . .	10	134.34	60.93	27	131.55	59.66	17	132.83	60.24	2	133.06	60.35

TABLE No. 8. — Continued.

PARENTAGE IRISH.

AGE AT LAST BIRTHDAY.	Occupation of Parents.											
	PROFESSIONAL.			MERCANTILE.			SKILLED LABOR.			UNSKILLED LABOR.		
	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.
Five . . .	1	38.50	17.46	23	40.85	18.53	100	41.29	18.73	235	41.33	18.74
Six . . .	3	42.33	19.20	45	45.53	20.65	158	45.46	20.62	309	45.14	20.48
Seven . .	1	43.50	19.73	40	49.58	22.49	219	47.98	21.76	336	49.57	22.48
Eight . .	1	50.	22.68	51	55.11	25.00	209	53.44	24.24	329	54.31	24.63
Nine . . .	2	62.	28.12	46	59.05	26.78	186	58.58	26.57	306	59.04	26.78
Ten . . .	1	66.	29.93	43	67.40	30.57	181	63.26	28.69	323	65.50	29.71
Eleven . .	2	67.50	30.61	43	69.96	31.74	195	69.27	31.42	285	69.61	31.57
Twelve . .	2	75.12	34.07	35	77.92	35.34	161	74.71	33.89	281	76.12	34.53
Thirteen . .	1	105.25	47 74	29	87.46	39.67	147	81.62	37.02	249	82.88	37.59
Fourteen . .	3	79.91	36.24	33	88.28	40.04	103	90.48	41.04	176	91.79	41.63
Fifteen . .	1	103.25	46.83	17	98.06	44.47	58	101.58	46.08	74	102.59	46.53
Sixteen . .	–	–	–	14	116.62	52.90	23	111.82	50.72	20	117.03	53.08
Seventeen . .	–	–	–	6	119.15	54.04	8	125.99	57.15	10	123.29	55.92
Eighteen . .	–	–	–	3	152.16	69.01	1	145.	65.77	1	127.50	57.84

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TABLE No. 4.—*Showing Average Heights (without shoes) of Boston School Girls.*

PARENTAGE AMERICAN.

AGE AT LAST BIRTHDAY.	OCCUPATION OF PARENTS.											
	PROFESSIONAL.			MERCANTILE.			SKILLED LABOR.			UNSKILLED LABOR.		
	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.
Five . . .	6	42.16	107.1	42	42.08	106.9	56	41.40	105.2	18	40.60	103.1
Six . . .	16	44.24	112.4	63	44.74	113.7	103	43.50	110.6	48	43.26	109.9
Seven . .	21	45.04	114.4	114	46.22	117.5	139	45.95	116.8	60	45.68	116.1
Eight . .	16	48.77	124.0	131	48.16	122.4	137	47.91	121.8	48	48.17	122.4
Nine. . .	15	50.20	127.6	95	49.78	126.5	148	49.40	125.5	45	49.39	125.5
Ten . . .	13	51.83	131.7	116	51.86	131.7	142	51.75	131.5	48	51.77	131.5
Eleven . .	17	53.78	136.6	101	53.62	136.3	117	54.	137.2	41	53.05	134.8
Twelve . .	19	55.48	140.9	113	56.77	144.2	115	56.68	144.	44	56.94	144.7
Thirteen . .	20	60.02	152.4	87	58.90	149.6	141	58.68	149.1	35	58.31	148.2
Fourteen . .	22	59.94	152.3	118	60.53	153.8	106	60.16	152.9	23	60.77	154.4
Fifteen . .	31	61.77	157.	92	61.14	155.4	83	61.71	156.8	19	61.34	155.8
Sixteen . .	18	61.22	155.6	95	61.56	156.4	74	61.60	156.5	19	62.12	157.9
Seventeen . .	21	62.21	158.1	54	61.95	157.4	44	61.84	157.2	8	62.88	159.7
Eighteen . .	15	62.94	159.9	50	62.27	158.2	26	61.48	156.2	2	61.85	157.2

TABLE No. 4. — Continued.

PARENTAGE IRISH.

AGE AT LAST BIRTHDAY.	OCCUPATION OF PARENTS.											
	PROFESSIONAL.			MERCANTILE.			SKILLED LABOR.			UNSKILLED LABOR.		
	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.
Five . . .	–	–	–	23	41.68	105.9	86	40.82	103.7	149	41.48	105.4
Six . . .	–	–	–	33	43.72	111.2	114	43.38	110.2	259	43.20	109.7
Seven . .	1	44.60	113.3	33	45.33	115.2	130	45.16	114.7	262	45.48	115.4
Eight . .	–	–	–	49	47.78	121.4	104	47.28	120.1	285	47.45	120.6
Nine. . .	–	–	–	27	49.95	126.9	140	49.45	125.6	273	49.21	125.1
Ten . . .	3	52.96	134.6	37	51.75	131.5	125	51.05	129.7	250	51.06	129.7
Eleven . .	–	–	–	33	54.08	137.4	108	54.23	137.8	229	52.98	134.6
Twelve . .	1	56.20	142.8	28	55.10	140.	99	55.50	141.	183	55.29	140.5
Thirteen . .	–	–	–	28	57.50	146.1	79	57.49	146.	101	57.64	146.5
Fourteen . .	–	–	–	31	60.16	152.9	61	59.29	150.6	90	59.74	151.8
Fifteen . .	3	60.56	153.9	12	61.08	155.2	41	60.36	153.4	44	60.34	153.4
Sixteen . .	–	–	–	14	61.47	156.2	18	61.01	155.	20	60.52	153.8
Seventeen. .	1	62.80	159.6	2	60.80	154.5	9	61.72	156.9	4	63.60	161.6
Eighteen . .	–	–	–	1	60.60	154.	8	60.50	153.8	1	64.80	164.7

TABLE NO. 6. — *Showing Average Heights (without shoes) of Boston School Boys.*

PARENTAGE.

AGE AT LAST BIRTHDAY.	AMERICAN.						IRISH.					
	NON-LABORING.			LABORING.			NON-LABORING.			LABORING.		
	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.
Five . . .	62	41.94	106.5	135	41.71	106.0	24	40.98	104.1	335	41.59	105.6
Six . . .	119	44.46	113.	216	43.89	111.5	48	43.60	110.8	467	43.76	111.2
Seven . .	141	46.59	118.4	218	45.99	116.9	41	46.03	117.	555	45.56	115.8
Eight . .	144	48.53	123.4	246	47.93	121.8	52	47.60	121.	538	47.68	121.2
Nine . . .	130	50.37	128.	239	50.08	127.2	48	49.80	126.5	492	49.63	126.2
Ten . . .	139	52.35	133.	195	51.96	132.	44	51.78	131.5	504	51.55	131.
Eleven . .	154	54 50	138.5	185	53.75	136.6	45	53.34	135.5	480	53.06	134.8
Twelve . .	165	56.47	143.5	177	55.30	140.5	37	55.55	141.2	442	54.75	139.2
Thirteen . .	170	58.51	148.8	187	57.83	147.	30	57.78	146.8	396	56.59	143.8
Fourteen . .	181	61.30	155.3	172	60.33	155.4	36	58.36	148.3	279	58.71	149.2
Fifteen . .	159	63.18	160.5	149	62.31	158.8	18	60.45	153.6	132	61.34	155.9
Sixteen . .	119	65.49	166.4	92	65.54	166.5	14	65.23	165.8	43	63.67	161.8
Seventeen . .	70	66.41	168.7	43	65.94	167.6	6	65.	165.1	18	66.32	168.5
Eighteen . .	37	66.96	170.1	19	66.35	168.6	8	68.03	172.8	2	67.25	170.9

TABLE No. 7.—*Showing Average Weights (in ordinary dress) of Boston School Boys.*

PARENTAGE.

AGE AT LAST BIRTHDAY.	AMERICAN.						IRISH.					
	NON-LABORING.			LABORING.			NON-LABORING.			LABORING.		
	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.
Five . . .	62	41.43	18.79	135	40.91	18.57	24	40.75	18.48	335	41.32	18.74
Six . . .	119	45.61	20.74	216	44.81	20.33	48	45.33	20.56	467	45.25	20.52
Seven . .	141	50.	22.68	218	49.09	22.27	41	49.43	22.42	555	48.94	22.20
Eight . .	144	55.06	24.97	246	53.86	24.43	52	55.01	24.95	538	53.97	24.48
Nine . . .	130	61.09	27.71	239	59.81	27.13	48	59.17	26.84	492	58.87	26.70
Ten . . .	139	66.05	29.96	195	66.38	30.11	44	67.37	30.56	504	64.70	29.35
Eleven . .	154	73.47	33.28	185	71.79	32.56	45	69.85	31.68	480	69.45	31.50
Twelve . .	165	82.72	37.52	177	77.47	35.14	37	77.77	35.28	442	75.61	34.30
Thirteen . .	170	90.24	40.93	187	86.70	39.33	30	88.05	39.94	396	82.41	37.38
Fourteen . .	181	99.66	45.20	172	98.25	44.57	36	87.59	39.80	279	91.32	41.42
Fifteen . .	159	110.58	50.16	149	108.	48.99	18	98.35	44.61	182	102.15	46.33
Sixteen . .	119	123.82	56.16	92	122.83	55.71	14	116.62	52.90	43	114.24	51.82
Seventeen . .	70	129.20	58.60	43	128.62	58.34	6	119.15	54.04	18	124.49	56.47
Eighteen . .	37	132.30	60.01	19	132.86	60.26	3	152.16	69.02	2	136.25	61.80

TABLE No. 8.—*Showing Average Height (without shoes) of Boston School Girls.*

PARENTAGE.

AGE AT LAST BIRTHDAY.	AMERICAN.						IRISH.					
	NON-LABORING.			LABORING.			NON-LABORING.			LABORING.		
	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.	No. of Observations.	Inches.	Centimeters.
Five . . .	48	42.09	107.0	74	41.20	104.7	23	41.68	105.9	235	41.24	104.8
Six . . .	79	44.64	113.4	151	43.42	110.4	33	43.72	111.1	373	43.28	109.9
Seven . .	135	46.03	117.0	199	45.86	116.6	34	45.31	115.2	401	45.34	115.2
Eight . .	147	48.23	122.6	180	47.97	121.9	49	47.78	121.4	449	47.37	120.4
Nine. . .	110	49.84	126.7	193	49.40	125.5	27	49.95	126.9	413	49.29	125.2
Ten . . .	129	51.86	131.8	190	51.76	131.5	40	51.84	131.7	375	51.06	129.7
Eleven . .	118	53.64	136.3	158	53.75	136.6	33	54.08	137.4	337	53.38	135.6
Twelve . .	132	56.59	143.8	159	56.75	144.2	29	55.14	140.1	282	55.36	140.6
Thirteen . .	107	59.10	150.2	176	58.60	148.9	28	57.50	146.1	240	57.59	146.3
Fourteen . .	140	60.44	153.6	129	60.27	153.2	31	60.16	153.0	160	59.57	151.4
Fifteen . .	123	61.30	155.7	102	61.64	156.7	15	60.98	154.9	85	60.35	153.4
Sixteen . .	113	61.50	156.3	93	61.71	156.9	14	61.47	156.2	33	60.71	154.3
Seventeen. .	75	62.02	157.6	52	62.00	157.5	8	61.46	156.2	13	62.30	155.7
Eighteen . .	65	62.42	158.6	28	61.50	156.3	1	60.60	154.0	4	61.57	156.5

TABLE No. 9. — *Showing Average Weight (in ordinary dress) of Boston School Girls.*

PARENTAGE.

AGE AT LAST BIRTHDAY.	AMERICAN.						IRISH.					
	NON-LABORING.			LABORING.			NON-LABORING.			LABORING.		
	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.	No. of Observations.	Pounds.	Kilograms.
Five . . .	48	41.22	18.69	74	38.83	17.61	23	41.32	18.74	235	39.64	17.98
Six . . .	79	44.43	20.15	151	43.47	19.72	33	44.05	19.98	378	43.15	19.57
Seven . .	135	48.63	22.06	199	47.69	21.63	34	47.77	21.67	401	47.26	21.44
Eight . .	147	53.59	24.31	180	52.54	23.83	49	53.05	24.06	449	51.62	23.41
Nine . . .	110	58.52	26.54	193	56.74	25.74	27	59.03	26.78	413	56.65	25.69
Ten . . .	129	64.78	29.38	190	63.47	28.79	40	63.64	28.87	375	61.35	27.83
Eleven . .	118	70.20	32.58	158	69.83	31.67	33	71.58	32.47	337	67.27	30.51
Twelve . .	132	81.51	36.97	159	81.20	36.83	29	75.98	34.46	282	75.89	34.42
Thirteen . .	107	92.00	41.73	176	90.47	41.04	28	84.75	38.44	240	85.68	38.84
Fourteen . .	140	100.23	45.46	129	99.75	45.24	31	98.61	44.73	160	96.14	43.61
Fifteen . .	123	108.37	49.15	102	109.28	49.57	15	104.75	47.50	85	99.23	45.01
Sixteen . .	113	111.02	50.36	93	115.50	52.39	14	110.62	50.17	33	106.33	48.23
Seventeen . .	75	116.30	52.75	52	115.14	52.22	3	110.75	50.24	13	121.83	55.26
Eighteen . .	65	116.43	52.81	28	113.79	51.61	1	98.50	44.68	4	106.06	48.11

labor into a "laboring," group of occupations. The ave heights and weights resulting from this classification given in tables 6, 7, 8, and 9. Even in this grouping of observations, the irregularities alluded to have not entirely eliminated. Observations on children of I parents of the non-laboring classes are particularly fev number, a circumstance which introduces considerable certainty into conclusions which might otherwise be established.

The conclusions to be drawn from an examination of t tables are indicated by the curves on Plates II.–IX. glance at the curves on Plate II., for instance, shows at that the sons of non-laboring American parents are, at al all ages, both taller and heavier than the sons of labo parents of the same nationality. Plate III. shows the s general fact for girls, though here the difference is much striking than in the case of boys. It must not, howeve supposed that the superior size of the children of non-la ing American parents is *wholly* due to the fact that t growth takes place under conditions of greater comfort luxury; for it is evident that among the parents recorde American there must be a considerable number who, tho themselves American, are the children of Irish parents, it is also evident that this class will be relatively n numerous in the laboring than in the non-laboring pop tion. Hence the smaller size of children of laboring An can parents, as compared with those of the non-labo classes of the same nationality, may be partly due to a la admixture in the former class of children of American entage, but of Irish extraction.

The curves on Plates IV. and V. show, in a similar for the Irish nationality, the superior size of children of non-laboring classes; and here the result must evidentl due to differences in the mode of life, for there is no re to suppose that any want of homogeneousness in the will affect the non-laboring and the laboring classes i different way. Unfortunately, the curves representing growth of children of non-laboring Irish parents are ra irregular, owing to the small number of observations f which they are constructed; and the conclusions to be dr from their examination are therefore somewhat less pre

'ould have been the case, had the data been more ›us.

: additional light may be thrown upon the question of ıtive importance of race and mode of life in determin- rate of growth, by comparing together the children ient nationalities in the laboring and also in the non- g classes. The curves on Plates VI.–IX. show the ıf this comparison. An examination of these curves in :ion with those on Plates II.–V. shows that in general an children differ rather more from Irish children of ıe social class, than children of the non-laboring classes :om those of the laboring classes of the same nation- in other words, race seems to be of somewhat more ınce than mode of life in determining the rate of . This result confirms to a certain extent the conclu- ıched by Boudin[1] from an examination of recruits to ny in different departments of France; viz., that stat- o a great extent "independent of comfort and misery, on the contrary, closely connected with race." The ɔneral fact seems to be also indicated by a comparison rates of growth of the children of the laboring and oring classes, irrespective of their nationality. In No. 10 and 11 are found the data necessary for this :, and on Plates X., XI., are given the results of the ison. An examination of these curves in connection ıose on Plates VI., VII., of the former article,[2] shows hen the observations are grouped without reference to upation of the parents, American children differ more rish children, than the children of the non-laboring differ from those of the laboring classes when the .tions are grouped irrespective of nationality.

ɔugh the result of this investigation seems to show ›de of life, as indicated by the occupation of the par- less important than race in determining the rate of of children, yet there are several considerations which , necessary to exercise a good deal of caution in accept- ; conclusion as one of general application.

ıe first place, it was shown in the former article on Growth of Children,"[3] that, according to the figures

revious article, "The Growth of Children;" Board of Health Report, 72. [2] Op. cit., p. 290. [3] Op. cit., table No. 20, Plate VIII.

TABLE No. 19.—*Showing Average Heights and Weights of Boston School Boys, irrespective of Nationality.*

AGE AT LAST BIRTHDAY.	OCCUPATION OF PARENTS.									
	NON-LABORING.					LABORING.				
	No. of Observations.	Height.		Weight.		No. of Observations.	Height.		Weight.	
		Inches.	Centimeters.	Pounds.	Kilograms.		Inches.	Centimeters.	Pounds.	Kilograms.
Five	135	41.64	105.8	41.21	18.70	694	41.57	105.6	41.00	18.60
Six	243	44.11	112.1	45.50	20.64	1,007	43.74	111.2	45.06	20.44
Seven	294	46.23	117.5	49.77	22.57	1,133	45.61	116.0	[illegible]	22.10
Eight	295	48.08	122.2	54.64	24.78	1,161	47.67	121.2	53.07	24.84
Nine	272	50.03	127.1	59.89	27.16	1,097	49.73	126.4	[illegible]	[illegible]
Ten	262	52.12	132.5	66.31	30.08	1,023	51.55	131.0	[illegible]	[illegible]
Eleven	284	53.84	136.8	71.81	32.57	956	53.17	135.1	69.07	31.00
Twelve	277	55.92	142.1	80.38	36.46	899	54.84	139.4	75.88	34.42
Thirteen	277	58.13	147.7	88.59	40.18	800	56.89	144.5	83.40	37.88
Fourteen	265	60.52	153.8	96.54	43.79	582	59.31	150.7	93.07	42.40
Fifteen	231	62.68	159.3	108.81	49.36	365	61.90	157.3	104.88	47.07
Sixteen	169	65.28	165.8	122.48	55.56	162	64.65	164.3	110.03	[illegible]
Seventeen	97	66.17	168.1	128.23	58.16	77	65.75	167.1	125.28	[illegible]
Eighteen	46	66.69	169.4	132.00	59.87	28	66.35	168.6	131.00	59.09

TABLE No. 11.—*Showing Average Heights and Weights of Boston School Girls, irrespective of Nationality.*

AGE AT LAST BIRTHDAY.	OCCUPATION OF PARENTS.									
	NON-LABORING.					LABORING.				
	No. of Observations.	Height.		Weight.		No. of Observations.	Height.		Weight.	
		Inches.	Centimeters.	Pounds.	Kilograms.		Inches.	Centimeters.	Pounds.	Kilograms.
Five	120	41.66	105.9	40.55	18.39	491	41.26	104.8	39.48	17.91
Six	172	44 12	112.1	44.14	20.02	809	43.24	109 9	43.13	19.56
Seven	247	45.71	116 3	48 02	21.73	921	45.41	115.4	47.16	21.39
Eight	207	47.92	121.8	52 79	23 94	982	47.47	120.6	51.81	23.50
Nine	224	50 16	127.5	58 78	26.66	913	49.27	125.2	56.74	25.74
Ten	232	51.66	131.3	63.76	28.92	854	51.25	130.3	61.98	28.11
Eleven	210	53.66	136.4	70.40	31 97	719	53.41	135.7	68.01	30 85
Twelve	237	56.16	142.7	80.18	36.37	671	55.70	141.5	77.52	35.16
Thirteen	101	58.67	149.1	90.68	41.13	593	58.01	147.4	87.88	31.66
Fourteen	226	60.28	153.2	99 40	45.09	419	59.84	152.1	97.92	44.42
Fifteen	168	61.19	155 5	107.70	48 85	258	61.00	155.0	105.11	47.68
Sixteen	147	61.46	156.2	111.22	50.44	169	61.55	156.5	112.59	51.07
Seventeen	98	61.88	157.3	115.15	52.23	89	61.92	157.4	115.72	52.49
Eighteen	77	62.26	158.2	115.83	52.54	46	61.70	156.8	112.94	51.23

furnished by Mr. Roberts, the sons of the English non-laboring classes are decidedly taller, and at most ages also heavier, than the children of the laboring classes, the difference in height amounting at thirteen years of age to upwards of four inches. The same fact is still more strikingly shown in the tables of a recently published work[1] by the same author. It is evident, therefore, that in England, where the population is comparatively stationary and homogeneous in character, the occupation of the parents has a very decided effect upon the size of growing children.

In the second place, it is evident that no grouping of occupations can possibly divide an American community into such distinct social classes as are to be found in English society. Hence the effect of mode of life on the growth of children, though it may not be less powerful in this country than in England, will not reveal itself so readily in statistical tables, owing to the difficulty of grouping the observations in a suitable way.

Although it appears, therefore, from this research, that the superiority in size of the children of the non-laboring over those of the laboring classes is much less marked in this country than in England, it does not necessarily follow, either that comfort and misery affect the growth of children less powerfully here than elsewhere, or that the difference is due wholly to the fact that the laboring classes in this country are better able to command the comforts and luxuries of life than the corresponding classes in England.

Taking these circumstances into consideration, it will probably be safe to conclude that the importance of mode of life, as a factor in determining the size of growing children in this community, is at least equal to, and possibly even greater than, that of race.

[1] A Manual of Anthropometry, by Charles Roberts, F.R.C.S. London, J. & A. Churchill, 1878.

Anthropometrical Methods.

Since questions in anthropometry require for their solution the collation and comparison of observations which can be obtained in sufficient numbers only by the united efforts of many investigators, it is perhaps desirable to give in this connection a brief account of the most approved methods of research.

A systematic attempt to collect observations of this sort has been made in England. The Anthropometrical Committee of the British Association, 22 Albemarle Street, London, W., has published for distribution blank forms with columns headed as follows: —

Name and Surname. — (The initials will suffice.)

Where Born. (State parish and county.) If born abroad, state the name of the country.

Rank, Profession, or Occupation.

Race. — English, pure English, very pure English, Scotch, pure Scotch, very pure Scotch, or mixed Scotch and English, &c.

Origin. Countryfolk, pure countryfolk, very pure countryfolk, C. birth, T. since boy. Townfolk, pure townfolk, very pure townfolk, T. birth, C. since boy, &c.

Sex.

Age, in years and months; years and twelfths.

Height, without shoes; in inches and eighths.

Weight, when in ordinary in-door costume; in pounds, without shoes.

Eyes. — Gray, light blue, blue, dark blue, light brown, brown, dark brown, green, black.

Hair. — 1, Very fair; 2, fair; 3, golden; 4, red; 5, red brown; 6, light brown; 7, brown; 8, dark brown; 9, black brown; 10, black.

Exceptional Measurements.

Chest. — Girth in inches and eighths. Breathing capacity in cubic inches.

Strength of Arm. — Drawing power in pounds.

Sight. — Test dots can be distinguished at how many feet and inches.

Each form is ruled for twenty sets of observations: and the following circular of instructions explains the object of the investigation, and the precautions to be observed in making the measurements.

General Instructions to be observed in filling up Certain of the Columns.

[As the object is to obtain a fair average, take care to exercise perfect impartiality of choice in the selection of cases.]

It is desirable, before beginning the measurements, that the various scales should be carefully verified. Accurate measurements with erroneous scales are much more misleading than off-hand measurements with correct scales.

Please write clearly.

Each sheet contains 20 lines, one line for each separate entry.

The return is required in order to inquire into physical differences under the following heads: —

1. Persons engaged in different occupations.
2. Persons bred and living in towns or country.
3. Natives of parts of the British Isles differing ethnologically, geologically, or in climate.
4. Boys and young men whose intellect and industry are above or below the average.
5. The general characteristics of men noted for athletic power.
6. The rate of growth in persons bred in town and country, and engaged in different occupations.

[Other topics of inquiry may hereafter be added.]

Race. — By the phrase "purely English," &c., it is understood that both the father and the mother were commonly reckoned as "English," &c. In those cases where the history of all four grandparents is well known, and they were all reckoned to be of the same race, the entry may have the word "very" prefixed; thus, "very pure English," &c.

Origin. — If both the father and the mother had been commonly reckoned as countryfolk, from their own birth up to that of their children, the entry should be "purely countryfolk." In cases where the history of all four grandparents is well known, and where they, *as well as* the parents, were all of them countryfolk in the sense just mentioned, the entry should have the word "very" prefixed; thus, "very pure countryfolk."

Similar instructions to be observed as regards townsfolk.

Sex. — It is proposed that the inquiry should, at first, be limited to males except for a few special objects.

Age. — It is important that the age should be given in years and months (twelfths), both for children and adults.

Height. — To be given in inches and eighths.

Weight. — To be given in *ordinary* in-door costume. Exceptionally thick boots, such as laborers wear, must be taken off.

Eyes. — The entries should be of the form "light blue," "dark blue," or simply "blue" if the eye be neither dark nor light. The color of the iris should be viewed at such a distance that minor variations may blend into one general hue and tint. Thus green should be entered either as gray or blue, according to the prevalent appearance.

HAIR. — In addition to the colors mentioned in the column of the schedule, some other words may be adopted, such as sandy, yellow, auburn, chestnut. When the hair has begun to turn gray, the color it used to have should be given, with the word "formerly" prefixed; thus, "formerly black."

EXCEPTIONAL MEASUREMENTS.

These require more time and instrumental appliances than the foregoing: nevertheless it is hoped that they will be undertaken by many observers, on account of their value and interest.

GIRTH OF CHEST. — Make the person stand quite upright, with his shoulders back, and his arms hanging loosely by his side. The measurement must be taken next to the skin. The lower edge of the tape should touch the nipples, and the measurement shonld be read off in front. Care should be taken that the tape passes horizontally round the chest; because if the measurement is made obliquely, below the blade-bone, it will be erroneous. The person should be required to count 10 slowly during the operation, to prevent him from keeping his lungs over-inflated.

BREATHING CAPACITY. — Any good spirometer may be used. A convenient one consists of a graduated mackintosh cylindrical bag, much like the sleeve of a coat, closed at one end, and having a mouthpiece and a stop-cock at the other. (These spirometers are made by Coxeter & Son, surgical-instrument makers, 23 Grafton Street, East, Tottenham Court Road, London; price £1, 4*s*.) When using it, the air is entirely pressed out of the bag by rolling it up, then the stop-cock is closed. The person now takes it in his hand, prepares himself for a long breath, puts the mouthpiece to his mouth, opens the stop-cock, and breathes in. When the expiration is completed, he closes the stop-cock, and thus shuts up in the cylindrical bag the volume of air that it is desired to measure. To effect this, the mouthpiece is taken off, and laid transversely across the mouth end of the cylindrical bag; this is to be rolled up tightly round it, until the loose end of the cylinder becomes thoroughly tense from the included air; at that point the graduation marked on the bag is to be read off. (The breathing capacity is an important measure of vital energy, after the necessary corrections have been applied, with regard to the height and weight of the person observed.)

STRENGTH OF ARM. — It is proposed to measure the force that can be exerted by the arm when pulling (as an archer with a bow) in a horizontal direction, either against a graduated spring, or against a cord passing over a pulley and attached to a scale pan below, on which weights are placed. The right or left arm, whichever is the strongest, should be used to draw, and the other to resist. The resisting arm must be held straight, and the hand of the other arm brought back to the ear.

SIGHT. — This is to be measured by the distance at which the test-dots can be counted. Each test-dot is $\frac{1}{50}$ inch square. Cards of them can be had on application to the Secretary of the Anthropometric Com-

mittee. In making the measurement, a tape or other scale graduated to feet and inches must be fixed or hung horizontally, at a height of about 6 feet 3 inches above the ground. The person to be examined must stand under this, and the greatest distance must thereby be found at which he can clearly distinguish and count the dots. Hold the test-dot card perfectly upright in front of the person, and *let it face the light so as to be fully illuminated.* Expose some of the dots (not more than seven or eight at the time) by covering the remainder with a card or a piece of paper, and desire the person to name their number and relative positions. By using a covering card with a square portion cut out of one corner, six different groups of dots may be exposed without exceeding the number of dots above mentioned. Vary the groups frequently, to provide against deception. Keep the card of test-dots perfectly clean.

These forms, though intended particularly for use in Great Britain, may, with very slight modifications, be advantageously employed in similar researches in other countries.

For those engaged in anthropometrical investigations, the "Manual of Anthropometry," by Charles Roberts, F.R.C.S.,[1] will be found to contain much important information and many valuable suggestions. Accompanying the volume (and also to be obtained separately) is an elaborate chart giving instructions for making and recording a large number of measurements of various parts of the body, and containing a set of ruled co-ordinates for recording graphically the variations of any of the measurements at successive periods.

In this connection should also be mentioned a publication entitled "The Mother's Register,"[2] translated from the French of Professor J. B. Fonssagrives, and intended to encourage parents to record observations of various sorts on their growing children. Were such records extensively kept, a body of observation would soon be accumulated which would be of great value to the student of vital statistics.

In all statistical investigation, as soon as the observations become sufficiently numerous to give any great value to the conclusions to be drawn from them, the work of tabulating them so as to make these conclusions possible becomes extremely burdensome; and where very large bodies of figures are to be handled, as, for instance, the observations on more than half a million drafted men analyzed by Dr. Baxter, the magnitude of the work is such that it can be properly under

[1] London, J. & A. Churchill, 1878.

[2] New York: The Nation Press, John Ross & Co., 1872.

taken only by a national government. Any device, therefore, by which this labor can be reduced to a minimum, will be welcome to those engaged in researches of this sort. This reduction can be best effected by a method extensively used in Germany, which consists in recording *on a separate piece of paper or card* all the observations made upon, and all the facts relating to, each individual case. To understand the advantages of this method, it will be well to consider how our study of the growth of children would have been modified, had it been conducted in accordance with this plan. Instead of collecting the observations on fifty or sixty children upon a single blank form headed as described on p. 277 of the former article (p. 5 of the reprint) the same facts would have been recorded for each child upon a separate card, printed somewhat as follows: —

Vital Statistics.

.................School for .... Boston,.............. 187 .

Name (or initials) ....

Age .... years .... months.

Height (without shoes) nearest centimeter ....

Weight (in ordinary clothes) nearest kilogram.........................

Birthplace ....

Nationality of Parents { Father ....
Mother ....

Occupation of Parents ....

Name (or initials) of observer ....

The handling of statistics collected in this way is exceedingly simple. If it is desired, for instance, to ascertain the height of boys of American parentage at different ages, the collected cards are to be sorted as follows: —

1. To separate the boys from the girls.
2. To separate the boys of American from those of foreign parentage.
3. To separate the boys of American parentage into groups corresponding to the different ages.

4. To subdivide these groups into smaller groups corresponding with each centimeter of height.

The number of cards in each of these smaller groups is then counted and recorded. By treating the observations of each age in this way, tables are obtained, like tables 4–15 of the former article, showing at a glance the distribution of all the observations taken, as well as the *mean* height for each age; i.e., the height on which the greatest number of observations fall; or, in other words, the height of the group containing the largest number of individuals. The *average* height for each age, which is not necessarily the same as the mean height,[1] is obtained by multiplying the number of observations in each group by the height of that group, adding together the products thus obtained, and dividing the sum by the total number of observations for each age.

As an illustration of this method, suppose the height of 1,000 boys of American parentage and five years of age to have been recorded at the nearest centimeter. If grouped in the manner above described, these observations will be found to be distributed somewhat as follows: —

Height. Nearest Centimeter	No of Observations.	Height × No. of Observations.	Height Nearest Centimeter.	No of Observations.	Height × No. of Observations.	Height. Nearest Centimeter	No of Observations.	Height × No. of Observations.
91	2	182	101	52	5,252	111	38	4,218
92	4	368	102	68	6,936	112	26	2,912
93	5	465	103	77	7,931	113	18	2 034
94	7	658	104	83	8,632	114	14	1,596
95	9	855	105	87	9,135	115	11	1,265
96	10	960	106	90	9,540	116	9	1,044
97	12	1,164	107	88	9,416	117	6	702
98	17	1,666	108	80	8,640	118	3	354
99	25	2,475	109	67	7,303	119	2	238
100	34	3,400	110	55	6,050	120	1	120
Totals. .	. .	. .	. .	. .	. .	. .	1,000	105,511

In this table the first column shows the height in centimeters of the successive groups in which the observations are arranged; the figures in the second column indicate the number of individuals contained in each group; while the figures of the third column, being the product of those in

[1] For a discussion of the difference between averages and means, the reader is referred to Roberts's Manual of Anthropometry, p. 69.

the first and second, show the sum of the heights of all the individuals in each group. The sum total of all the figures in the third column, viz., 105,511, is therefore the sum of the heights of the 1,000 individuals measured; and this sum divided by the whole number of observations, viz., 1,000, gives 105.5 centimeters, the average height of boys of that age and nationality. The mean height, it will be noticed, is 106 centimeters.

It will be observed that the units of the metric system have been used in this description, in preference to those of the English tables. This has been done for two reasons. In the first place, the metric system is rapidly becoming the universal language of quantity throughout the civilized world, and its general adoption in this country cannot be much longer delayed. It is important therefore, that observations should be recorded in a form which will render them easily comparable with those which may hereafter be taken in similar investigations, as well as with those already taken in countries which enjoy the benefits of the metric weights and measures. In the second place, it happens that for researches of this sort, the centimeter and the kilogram are much more convenient units than the inch and the pound; the inch being too large, and the pound being too small, to serve as a basis for forming successive groups of observations in the manner above described.

The advantages of this method of collecting and handling anthropometrical observations may be thus enumerated: —

I. *Saving of time in making the measurements.* Since the observations are distributed into groups differing from each other by successive centimeters or kilograms, the original measurements need be recorded with no greater accuracy than to the nearest centimeter or kilogram; and records of this sort can evidently be made much more rapidly than would be possible were greater precision required. Care must, of course, be taken to record those observations which fall about midway between two centimeters or kilograms, with the groups to which they really belong. For instance, all heights between 95.5 and 96.5 centimeters are to be recorded as 96; all between 96.5 and 97.5 centimeters, as 97 centimeters, &c.

II. *The work of tabulating is resolved into the sorting and*

counting of cards. All "intermediate tables" are thus d away with; the tables first constructed being those l adapted to display the results of the research.

III. *Great saving of expense.* Though the use of a se rate card for each individual observed necessitates m printing than the employment of large blank forms, yet great saving of time and labor in tabulating the observati much more than compensates for the extra expense t incurred.

IV. *The same set of observations may be used for the s tion of a variety of questions.* Since the ways in which cards may be sorted are only limited by the number of fi recorded upon them, it is evident, that, were this the g erally adopted method of anthropometrical research, observations of each investigator could, after serving special purpose for which they were originally collected readily collated with other sets of statistics, and thus c tribute to the solution of questions of a more gen character.

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THE DEPARTMENT OF

PHYSICAL EDUCATION AND HYGIENE

IN AMHERST COLLEGE.

BY

PROFESSOR EDWARD HITCHCOCK, M.D.

PHYSICAL EDUCATION IN AMHERST COLLEGE.

"There is a Divine Image in the future to which the nation must aspire. The first step towards it is to improve the health of the present generation." — DR. WILLIAM FARR.

NOT only educators, but too many persons engaged in brain-work, are culpable in that the body is let alone, presuming that the physical organization of man will take care of itself, just as water runs down hill, or weeds grow; not remembering the absolute interdependence of body and brain. The fact is forgotten, that when both body and mind are in a healthy condition they are like sworn friends to each other, but when not in harmonious co-operation, — when either one is diseased or disordered, — they are like bitter enemies acting towards one another with the most destructive malignity. As a gifted author expresses himself, "Neither mental serenity nor mental development can exist with an unhealthy animal organization." The importance of a department caring for bodily health in our schools is well expressed by Dr. Tanner, who says: "What is really desirable is a methodical system of drill and exercise fitted to produce a sound constitution in the average boy. To secure this, every school ought to have a well-fitted gymnasium, attendance and work in which should be as regular and systematic as in the class-room."

From the beginning of the existence of the department of physical education in Amherst College, it has never been the desire to develop the muscular system at the expense of any other part of the body, as is too often understood to be the meaning of physical education or training. This department was not created, nor has it been developed, for the purpose of extraordinary attention to the muscular system. Its sole object has been to keep the bodily health up to the normal standard, so that the mind may accomplish the most work,

and to preserve the bodily powers in full activity for both the daily duties of college and the promised labor of a long life. Indeed, in that particular, the precept of Cicero has been literally followed; namely, that bodily exercise should have for its chief object the development of a capacity for rational work. At the same time, it has been equally desired, that the so-called exercises of this department should be mentally as well as physically enjoyed by the students, and not be made a tedious, mechanical, or heavy drill.

During the early administration of President Stearns, the apathy in relation to bodily health, the sad deaths of two promising young men, and the breaking down in health of others just at the end of their college courses, impelled him to protest against these failures as unnecessary, and to demand that the students should receive discipline in the care of their bodies as well as of their intellects, and that the government of the college should give a proper attention to physical health, as well as to the culture of those powers for which departments were ordinarily created and endowments made. The idea was also impressively set forth by him, that, without the support of well-developed bodily powers and functions, the mental faculties could not reach their full development. To his mind, there could be no perfect manly character and culture, without the proper blending and harmonious development of the three elements, the bodily, mental, and spiritual. In the year 1859, the sixth of his administration, the trustees of the college, by his advice, created a department of physical education and hygiene. In the language of the catalogue of 1861–2, "Its design is to secure healthful daily exercise and recreation to all the students; to instruct them in the use of the vocal organs, movements of the body, and manners, as connected with oratory; and to teach them, both theoretically and practically, the laws of health. This daily physical training is a part of the regular college course. The professor is an educated physician, and has not only a general oversight of the health of the college, but the students have the privilege of consulting him without charge. While the gymnasium will furnish opportunities for the highest physical training, the required exercises will be such as can be performed without undue effort or risk of injury."

The duties of this professorship were established by the trustees, upon the suggestions of one of their number, Dr. Nathan Allen of Lowell, as follows: —

1. To take charge of the gymnasium and give instruction to the students in gymnastics.

2. To have a general oversight of the health of the students, and to give such instruction on the subject as may be deemed expedient, according to the general plan stated by the president in his report, and under the direction of the faculty, like all the other studies.

3. To teach elocution, so far as it is connected with physical training.

4. To give lectures, from time to time, on hygiene, physical culture, and other topics pertaining to the laws of life and health, including some general knowledge of anatomy and physiology.

5. The individual appointed to have charge of this department must be a thoroughly educated physician, a member of the college faculty. It is distinctly understood that *the health of the students* shall, at all times, be an object of his special watch, care, and counsel.

At the same time, the faculty believed that the exercises should be conducted according to the following ideas: —

"1. The main object shall not be to secure feats of agility and strength, or even powerful muscle, but to keep in good health the whole body.

"2. All the students shall be required to attend on its exercises for half an hour, designated for the purpose, at least four days in the week.

"3. The instructor shall assign to each individual such exercises as may be best adapted to him, taking special care to prevent the ambitious from violent action and all extremes, endeavoring to work the whole body, and not overwork any part of it.

"4. While it may not be expedient to mark the gradation of attainment as in the intellectual branches, yet regularity, attention, and docility should be carefully noted, so as to have their proper weight in the deportment column of the student's general position.

"5. Some time shall be allowed out of study-hours for those volunteer exercises which different men, according to their

tastes, may elect for recreation; and particularly the bowling-alleys shall not be given up to promiscuous use, but allotted at regular hours to those who wish to make use of them: all these volunteer exercises, of whatever kind, to be under the supervision of the gymnasium-instructor.

"6. The building shall always be closed before dark; no light shall be used in it, and no smoking or irregularities of any kind shall be allowed in it.

"7. The instructor ought to be a member of the faculty, and give in to it his marks and occasional accounts, and receive directions as other officers of the college are accustomed to do."

This department is now in the eighteenth year of its existence. An essential feature of it is, that each student with his class by itself, at a stated hour on four days of the week, appears at the gymnasium, and performs his part in systematic and methodical exercises timed to music. Each class has its own organization of officers and men, and its own monogram on the college uniform dress of Middlesex blue flannel. The exercises are commonly known as those of light gymnastics, which consist of various bodily movements accompanied and guided by music; the larger part of them with a wooden dumb-bell in each hand. These are so arranged as to give vigorous and active motion to all the muscles of the body. With a temperature of 60° F., nine out of ten persons, at the close of a fifteen-minutes' exercise, with the metronome at 85 or 90, will show perspiration over a large part of the body. Especially during the colder season of the year, running is practised by the class on the floor of the gymnasium. A few marching movements are also undertaken by the classes. This amount of exercise is required of every student who is sound in limb.

The fact that physical education is placed on an equality of position with each of the other departments, and contributes to a recognition of the character and standing of the student in the college records, is probably its most striking feature as an educational measure. It is thus an indication that health and physical exercise are of prime importance. This recognition is not merely suggestive; but the enforcing of attendance to these duties tells the student that his character in college will be decided, in part, by the manner in which he

obeys the laws of his body, and attends to its proper care. Another feature made prominent in the exercises is that they shall not be of so mechanical and inflexible a nature as to destroy a free enjoyment of them.

While a necessary uniformity and periodicity are maintained, yet the elasticity of young nature is not so curbed that the student must act with the monotony of a machine, or with the absolute precision of the manual of arms, day by day, week by week, and year by year. For not only is this exercise of value to favor the chemical changes which accompany muscular activity; but it is desired, at the same time, to give the mind and spirits opportunity to escape, for the half-hour, from scientific and literary restraints and occupation, and enjoy the liberty of rational animal life; to allow the animal powers and sensibilities a chance for "full play;" to induce the material and social nature to such use and recreation as shall compensate its repression while engaged in the absorbing application of close study; or, in short, to compel the intellectual to rest while the material shall work. Hence a much greater latitude of noise, shouting, and freedom is allowed in connection with the exercises than would be expected by a school-teacher of gymnastics, or a drill-master; and it is allowed as an important element or safety-valve of the system. Professor W. S. Tyler in speaking of this matter says, "If I were asked to specify what I consider to be the most marked characteristic and distinctive excellence of the Amherst gymnastics, I should say that it is the union of recreation and amusement with exercise, of the voluntary and spontaneous with the required and the prescribed, — in a word, of play with work."

These exercises apparently satisfy and meet the necessities of probably nine-tenths of the students, as they come and go. Of the remainder, a few need special direction to undertake more muscular exercise in general, or the use of apparatus which shall help special organs or parts of the body. Such young men are generally those not in full development, or possessing an imperfect bodily inheritance, or with a tendency to use the brain at the expense of the bodily powers.

There are always a few in every class for whom the regular drill and the extra hour of walk, rain or shine, advised to all the college, does not satisfy the muscular energy. For

all such, there is an ample supply of so-called heavy gymnastic apparatus, in the form of bowling-alleys, Indian clubs, rowing-weights, bars, poles, boards, ropes, spirometers, and dynamometers, at which a few of them work, perhaps an hour a day, under reasonable requirements. This, with proper caution about excess, is not a compulsory part of the exercise.

When the plan of required physical exercise was first proposed, it was felt that while authority might compel study and attendance upon recitations, prayers, and lectures, it could not force muscular exercise and recreation upon anybody. The facts, however, in the matter, may be learned by comparing the attendance upon prayers and recitations with the gymnastic exercise. During the year 1877–78, the average daily attendance of all the college upon gymnastic exercises was 95.36 per cent. Statistics, secured at four different periods, of the absence from college-prayers, give an average attendance of 84.50 per cent, or over ten per cent in favor of the physical exercises. During the fall term of 1878, the same comparison was made between the President's recitations and lectures with the senior class in psychology, and the physical exercises in the gymnasium for all the college; with a result of 94 per cent for the former, and 94.8 per cent for the latter. The class of 1878, just before their graduation, in making out a series of statistics of opinions on matters reviewed by their course, gave 74 out of 77 as "in favor of compulsory attendance at the gymnasium exercises."

The system of exercises, as practised at Amherst, brings each student into the presence of the head of the department very frequently, and in such a way as to exhibit his physical condition to good advantage. Every thing in the gymnasium excites to jubilant muscular activity; and in no way does a young person show that he feels perfectly well, better than by active bodily — including vocal — movements. It is known that some people counterfeit sickness in order to avoid a duty or effort, but it is a rare occurrence for any one to feign excellent health. The professor in charge is required to know the physical condition of all the students during term-time, as far as possible. No student may be absent more than one day from college duties, without the

professor's excuse; though he may employ whatever physician he may choose, if ill or injured.

The statistics of this department show some interesting facts in reference to the duration of sickness among the students of the college. Dr. Edward Jarvis says that the average amount of time lost on account of sickness by each laborer in Europe is from 19 to 20 days each year; and in the Massachusetts Board of Health Report for 1872 it is estimated, that, for that year, 13 days' labor was lost by sickness for each productive person in the Commonwealth. The returns of Amherst College sick-list for term-time give 2.64 days as an annual average of time lost to every student, and of 11.36 days to each sick student, for 17 years.

The maladies from which the students have suffered are, as would of course be expected, the common, and, to some extent unavoidable, affections of young and vigorous men. Thirty-three per cent have been colds and catarrhal disorders. A little more than nine per cent have been from physical injury, though no serious accident has ever happened in the gymnasium. Eye-troubles have constituted five per cent; boils gave the same proportion. About five per cent were of tonsilitis and sore throat, and there were a few cases of typhoid or enteric fever. No epidemic has visited the college for the past twenty years.

A decrease in the amount of sickness during the course is an important feature in the health of the college. Taking the number on the sick-list in the Freshman year as 1,000, the number for the Sophomore year is represented by 912; for the Junior year, by 759; and for the Senior year, by 575. That is, the relative sickness of the different classes in the college is, in the Senior year 1.00; in the Junior year, 1.32; in the Sophomore year, 1.58; in the Freshman year, 1.74.

During the past 17 years, of the 1,262 different students in Amherst College, 56, or 4.44 per cent, have left the institution on account of alleged ill health. Of these 56, 36 have never returned; and 20 have re-entered and graduated, or are now members of the college. This loss amounts to a final giving up of the college-course by 2.85 per cent of all who have entered.

To secure a series of vital statistics from all the students of the college, is another duty belonging to the department

of hygiene. This consists of a record of certain bodily measurements made twice during the Freshman year and annually thereafter. The statistical records are, age, weight, height, girth of chest, girth of arm, girth of fore-arm, capacity of lungs, finger-reach, and body-lift, or a simple test of muscular strength. Dr. Hasket Derby, of Boston, during the past four years, has personally examined the eyes of every Freshman entering Amherst College, to ascertain the proportion and increase of near-sight among the students, and if possible to suggest the best preventive measures or treatment therefor. No results as yet have been obtained, as the first class examined is still in college. It is believed that such examinations for eight consecutive years will give much light on this subject so important to students.

It seems fair to suppose that the life of the student is as healthful as are lives in other occupations, if not more so. The student in the ordinary boarding-house or college dormitory is certainly no better cared for than are most young men of the same age[1] of the mercantile and many of the artisan class. His chance for physical exercise and out-door air and sunlight is much below that of a large part of mankind. There is no evidence that the student, with his inheritance and early environment, starts in life any better "selected" than do his playmates who enter the store, machine-shop, or the farm. In the matter of vacations, the student has the advantage, as usually his is distributed through the year over two or three periods, while most persons in other occupations are obliged to condense theirs into one, and that a period less than the amount enjoyed by the college student.

The results accomplished by this department in Amherst College lead its government to continue its existence, and sustain it on a par with the others, even though it may not be managed with the system and discipline of the sanitary organization in our army and navy. Even if its methods of management may not be such as can be used in other branches of educational work, yet it is certainly valuable to the student if by it he is able to maintain more than an average degree of health and work.

[1] From nineteen to twenty-three years, on an average.

COAL-GAS FROM HEATING APPARATUS.

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COAL-GAS FROM HEATING APPARATUS.

DURING seven months of the year, a fire is necessary to secure comfort and health within doors in Massachusetts. Anthracite (hard) coal maintains nine-tenths of these fires, it being the most economical and convenient fuel in the great majority of towns and villages; and it is therefore of the greatest importance that the community should be properly informed as to its good or ill effects on health. It is the object of the present paper to consider briefly and practically the gases resulting from the combustion of anthracite coal in their effect on health. The writer's attention has been called to the subject by reports to him, as corresponding secretary of the Massachusetts Medico-Legal Society, of the following several cases of coal-gas poisoning.

Medical Examiner Morison of Quincy reported views of five dead bodies in one household in Randolph, Dec. 19, 1877. These were five children named Ryan, aged from thirteen to four years, who had been "suffocated by coal-gas" during the previous night. The gas had escaped into the room where they slept, from a stove in which the fire had been arranged to keep all night by closing the damper in the smoke-pipe, and opening the stove-door. Probably fresh coal was added at the same time. The stove was a common cylindrical sheet-iron heater with a damper which fitted closely in the smoke-pipe.

Medical Examiner Abbott of Wakefield reported a view and autopsy of the body of a Mrs. Bragdon in Melrose in January, 1878, who had been "suffocated by coal-gas" during the previous night, while her husband, who was poisoned in the same way, died about twenty-four hours later. The house was heated by a Magee furnace, the "cold-air check" of which was found half-way open. Without doubt, fresh coal was put on the fire late in the evening.

From Dr. Abbott I also learn of two instances of similar poisoning, which did not result fatally. In Wakefield, early in 1878, a man and wife slept in a bedroom adjoining a sitting-room in which was a coal-stove. A snow-storm in the night covered and closed the chimney, so that the gases of combustion were forced back into the rooms. They were found partially unconscious by a son who slept in another room.

In Woburn, Feb. 6, 1869, a father, mother, and child slept in a small bedroom opening into a kitchen where was a cooking-stove with coal-fire.

The child's bed was low ("trundle") and near the floor. She was partially conscious, her parents were quite unconscious, when found in the morning. All recovered. The damper in the smoke-pipe was found completely closed; and in this instance, too, the usual addition of fresh coal at bedtime had doubtless been made.

In February, 1878, a young girl in Winchester was found in her bed in the morning, moaning and unconscious. The room and the hall into which it opened were filled with "stifling coal-gas." Fresh air quickly revived her; but she suffered from binding headache, dizziness, and oppression of the chest, for many hours. Her chamber was warmed by a fire of anthracite coal in an open stove, upon which ashes had been thrown, at the time the family went to bed, to prevent rapid combustion, and so keep the fire till morning; and although the room was not small, and a door was open into the hall, coal-gas escaped from the front of the stove in quantity sufficient to gradually stupefy the girl. She told the writer that she awoke from an uneasy sleep to find herself helpless, but not unconscious, as in a nightmare. She strove in vain to call her parents, to ring a hand-bell which had been placed within her reach, to rise from the bed. She vomited freely, and knew no more till she was roused in the morning. The sensations described by her correspond well to those experienced by persons who have attempted suicide by burning charcoal in their chambers, and have been discovered before stupor had lapsed into death.

Every one who reads the newspapers knows that no winter passes without the occurrence of several cases of severe or fatal poisoning from the escape of "coal-gas" into sleeping-rooms, where the unconscious occupants inhale it for hours. Of the *disagreeable* effects of this gas in smaller quantities and for shorter times, every one has had experience in rooms where the draught is insufficient, or the fire is ill-managed. We know that the air of such rooms has a peculiar smell and taste, quite distinguishable from that of air fouled by exhalations from the lungs and surface of human beings or by the escape of illuminating gas; a smell feebly acid and mineral, a taste feebly sweet and mineral. Not infrequently a sulphurous odor mingles with the other, perhaps quite disguising it. With this smell and taste we have learned to associate dull and constricting headache, heaviness and dryness of the eyes, languor of body and mind, and a desire for a long breath; feelings which can be got rid of only by leaving the room, or by admitting fresh air to it. Every one understands that the air of such rooms has been made bad by the escape into it of gases which should have gone up the chimney, and that it cannot be

wholesome. It is by no means every one who has it clearly in mind that such air is *poisoned*, and produces on those who breathe it a disturbance of health identical in kind with that which is occasionally fatal to persons sleeping in air strongly charged with the same poison.

What is this "coal-gas"? Disregarding its occasional and unimportant constituents, we may fairly consider it to be composed of carbonic oxide and carbonic dioxide (the latter still commonly termed carbonic acid gas). The dioxide is the gas formed when the carbon of the coal unites with the oxygen of the air (entrance-draught) to the extent necessary for complete combustion. The oxide is the gas formed when the carbon and oxygen unite to an extent insufficient for complete combustion. It is the dioxide which we smell and taste. The oxide is odorless and tasteless, yet it is by far the more dangerous and deadly of the two. Of the sulphurous odor before mentioned, we need only say that it arises from the sulphurous acid gas generated from traces of sulphur not uncommon in anthracite coal, and that it is so pungent and disagreeable as to compel attention and remedy before its inhalation has been tolerated to any deleterious degree.

Of all fuels in use, the three which come nearest to being pure carbon — and, therefore, to producing nothing but the oxides of carbon when burned — are charcoal, anthracite, and coke. Anthracite, on account of its density, is most difficult to bring to complete combustion, and therefore most apt to generate carbonic oxide, the product of imperfect combustion. The process which goes on in a recently kindled fire, or one to which coal has just been added, has been well described by the late Dr. George Derby, as follows:[1] —

[1] Anthracite and Health. By George Derby, M.D., 2d ed. A. Williams & Co., Boston, 1868.

Other works are: —

Coke as a Fuel in Relation to Hygiene. By Dr. C. B. Fox, London.

Leçons sur les Anesthésiques et sur l'Asphyxie. Par Claude Bernard, Paris, 1875.

Die Blutproben vor Gericht und das Kohlenoxydblut in Bezug auf die Asphyxie durch Kohlendunst. F. L. Huenfeld, Leipzig, 1875.

Die Lüftung und Erwärmung der Kinderstube und des Krankenzimmers. Haller.

The literature of the subject is fully discussed, and many original papers may be found, in the various numbers of the *Comptes Rendus*, and of the *Zeitschrift für Biologie.*

"The actual combustion of the lower range of coal in contact with the fire gives origin to carbonic acid gas. This, rising through the mass of heated coal above, is deprived of a portion of its oxygen, and issues from the surface as carbonic oxide gas. In this form it escapes by the flue for a period depending on the activity of the fire and the amount of air admitted. Finally, when the temperature of the mass is raised, if the supply of air is sufficient, it breaks into a pale blue flame signifying its reconversion into carbonic acid gas."

The investigations of chemistry and physiology into the oxide and dioxide of carbon have been long and ably pursued. With their results we are now concerned only so far as to say that carbonic dioxide in an undiluted form is generally considered by scientific men to be fatal by causing suffocation; i.e., it acts mechanically by excluding air, as water does in cases of drowning. Diluted with air it is a distinct poison, certainly in any proportion above 7 parts in 1,000.

Carbonic oxide is a most virulent poison, *even in very small quantity*, to all warm-blooded animals. A mixture of the oxide and dioxide is more harmful than either alone. The oxide when inhaled enters the blood-globules, and forms an intimate peculiar and persistent chemical combination with their coloring matter, thus disabling them for their proper function of exchanging gases with the air taken in inspiration. This combination is also recognized by means of the spectroscope.

Both the dioxide and the oxide are absorbed by red-hot *cast*-iron, and retained by it when cold; or, if it continues hot, the former will *pass through* it, while observers disagree as to its permeability to the oxide.

We have, then, the following series of facts: —

1. From the incomplete combustion of certain coals (notably anthracite), certain gases are produced, which when respired, even in mixture with atmospheric air, in a close room, are fatal to life.

2. Chemistry and physiology demonstrate that the most dangerous of these gases is carbonic oxide.

3. The changes wrought by this gas on the blood-globules are so peculiar and persistent as to be recognizable and demonstrable after death, by chemical analysis and spectrum analysis and by the microscope.

4. This gas, when so diluted with atmospheric air in any ordinary room as not to endanger life, causes in persons who respire it a train of symptoms, constant, peculiar, characteristic of narcotic poisons, and identical in *kind* with the symptoms experienced by persons who have been resuscitated after having been poisoned to insensibility by this very gas.

5. Carbonic dioxide, at least, passes into and *through* very hot cast-iron, under conditions inseparable from the ordinary use of heating-apparatus made of cast-iron.

An injury is done to health every time we breathe enough carbonic oxide to produce the train of symptoms previously described, — or even a much less quantity, since the result is that a gas known to fix itself so persistently in the minute elements of the blood is taken into the lungs about 1,080 times for adults, and about 1,800 times for babies, each hour.

Coal-gas may escape from stoves, furnaces, or open grates, *habitually* or *occasionally*. If habitually, then the draught is insufficient in smoke-pipe or chimney, or there is a leaky joint or a crack in the heating-apparatus. If occasionally, the heater is not properly managed.

To point out the remedy for insufficient draught, would be foreign to the purpose of this paper; but we may say in passing, that nothing but personal inspection by the head of the household at least twice a year, say, for instance, in June and October, will suffice to render it certain that smoke-pipes and flues are not narrowed by accumulations of soot and ashes. As to leaky joints, it is the belief of the writer that every furnace is liable to them at any period of its service, the liability increasing with the age of the furnace. The older the furnace, the more danger of its cracking, of course. There must be leaks or cracks of comparatively large size to cause an habitual escape of gas from a heating-apparatus which is known to have a good draught; and the apparatus must need faithful repairs, or perhaps removal. From minute leaks, gas may escape only under bad management, which, as has just been said, is usually the cause of the *occasional* escape of gas. Bad management is usually the result of a desire to economize fuel; for which purpose the fire must not be allowed to burn very freely, and to this end the exit-draught must not be strong.

Accordingly we have various devices for checking the

draught in the smoke-pipe, all of which, however, may be classed under one of two methods. (*a*) By some variety of valve ("damper") the smoke-pipe is narrowed at one point; or (*b*) by the admission of cold air to this pipe it is cooled, and thus the velocity of the current within it is lessened. By either method the draught is checked, the fire made to burn less fiercely, and the escape of the products of combustion by the proper channel is made less rapid and complete, while their tendency to escape into the room (or into the hot-air chamber of the furnace) is increased. Go somewhere they must; and, if there is an obstacle to their going up the chimney, they will come into the house, and when this occurs, fuel has been economized at the expense of health. Yet this "penny wise and pound foolish" economy is very common.

It would be to the advantage of the public health if these valves in the smoke-pipe could be completely abandoned. Certainly there should never be one so constructed as to be capable of *completely* closing the pipe, as is the case with very many now in constant use. To the credit of the best stove makers and dealers, it should be said that they never provide such dampers, unless by special order of the purchaser, which order, however, it is not uncommon for them to receive. It is evident that an accidental knock, a puff of wind down chimney, a meddlesome child, or an ignorant attendant, may at any time completely close the smoke-pipe provided with such dampers, and so turn all the coal-gas into the room. Even dampers so constructed as always to leave some aperture open are usually provided with too small a minimum of aperture, *one square inch* being not uncommon!

In "cold-air checks," on the contrary, the danger lies in providing an opening *into* the smoke-pipe too large or too direct, whereby the pipe may be too much cooled, or the exit current of hot gas be too directly met by an entering current of cold air; either of which contingencies may as completely stop the escape of coal-gas as though a tight damper were turned across the pipe. It is common for those who sell or use these cold-air checks, to point with satisfaction to the fact that the smoke-pipe provided with one barely feels warm to the touch, while yet the fire will "keep" for many hours. But a smoke-pipe should be decidedly *warm*, if it is to be a

safe conductor of carbonic oxide, which needs to be drawn away with more force than resides in a cool exit-pipe.

There is another method of checking the fire, which is in common use, in addition to those just mentioned; viz., by setting the feed-door of the fire-pot ajar, and at the same time closing the aperture below by which air is admitted under the fire. The effect is to substitute a current passing *over* the fire for one passing *through* it from below upward, and thus to make combustion less general and complete, and at the same time cool the heating-apparatus. A stove or furnace so arranged is provided with an extensive leak, from which coal-gas will freely escape whenever the smoke-pipe is narrowed or cooled as above mentioned. How promptly this will act, may be seen in many furnaces at the moment when the feed-door is opened. A sudden dart of blue flame rushes from the door sometimes with a slight but veritable explosion, which denotes the sudden conversion of the oxide into the dioxide of carbon. The flame of this explosion sometimes extends far enough to scorch the eyebrows and beard of the person who opens the door. On this account, certain furnaces have been furnished with special guards against this accident. The startling phenomena which accompany the escape of carbonic oxide under the circumstances just mentioned are wanting in the vast majority of instances where it really escapes, when its noxious qualities are as real as they are subtle and pervasive.

Again: coal-gas very frequently escapes into the house, because of its being suddenly generated in amount greater than the heating-apparatus was regulated for at the moment. This very often happens when fresh coal is added, bringing at once more carbon and less heat, and thus checking the complete combustion, and staying oxidation at the point where the oxide is produced instead of the dioxide. The proper thing to do is to make the escape-draught stronger just before fresh coal is added, a precaution which is very generally neglected by the managers of furnaces. If the fresh coal is *damp*, it exerts a still stronger influence for evil.

As it is for the sake of economy of fuel that these various obstacles are put in the way of the escape of coal-gas up chimney, and these facilities provided for its admission into our dwellings, it should be understood that there is a de-

cided *waste* of fuel, whenever we fail to carry combustion far enough to convert the oxide into the dioxide, — a waste amounting to 67 per cent of the proper heating power of the fuel. This argument may have weight with persons who are indifferent to the sanitary argument.

A community, which warms itself almost exclusively with anthracite coal, is not only incurring a risk, but suffering an injury, whenever the escape of coal-gas into its dwellings is appreciable. This slow poisoning, which goes on in so many homes and workshops, may account for many headaches, dyspepsias, neuralgias, &c. It is distinct from the poisonous influence of air fouled by having been already respired or by any other exhalation connected with overcrowding or with defective ventilation, which may exist in connection with any system of heating. The poison of anthracite coal-gas is something *added* to these dangers; something to which women and little children and invalids are subjected all day and all night, for months together.

Means of detecting the presence of coal-gas in advance of symptoms of poisoning are very desirable. To be of practical domestic value, they must not require the use of chemical tests or of any instruments. And fortunately the sense of smell is often of great assistance here, as in the detection of ordinary fouled air; for the oxide of carbon seldom escapes alone, but is usually accompanied by the pungent sulphurous gas. By smelling just above the fireplace, or the door of the stove or furnace, or near the cellar ceiling, one may often detect the slight odor of brimstone which is imperceptible elsewhere. When this is present, we may be certain that the two oxides of carbon are present too, since they — especially the deadly oxide — escape more readily than sulphurous acid, and are constantly formed where anthracite is burning.

To avoid breathing Coal-Gas.—We must secure the complete combustion of our coal, never allowing that state of the fire which gives us black coals with pale blue flame flickering over them, unless the draught is abundantly powerful to carry all gaseous products of combustion thoroughly up the chimney; a free and warm flue or smoke-pipe; a heater without leaky joints or cracks, and of sufficient size and power to do its work without being "driven hard." If a "damper"

is used, it should be considerably smaller than the pipe, or the centre of it should be perforated by a circular hole, — in either case, to such an extent that there never can fail to be a sufficient draught. Wrought-iron, fire-brick and soapstone, *with tight joints*, are better materials for stoves and furnaces than cast-iron or sheet-iron, when coal is used for fuel.

We must secure intelligent, faithful management of the heater, so that, at those times when the quantity of carbonic oxide is unavoidably increased, its escape up chimney may be freest, while yet the dwelling is maintained at a proper and equable temperature. Management of this kind is harder to secure than is a good heater or a free flue. It has been said that "It needs a philosopher to run a furnace properly;" but it certainly is to persons far from philosophical or observant that the care of most furnaces is intrusted, especially in our public schools. And on this account any automatic contrivance which will properly regulate the "draughts" of a furnace in relation to the temperature of a dwelling must be considered very desirable. Certain "governors" or "regulators" of this nature, now in the market, are said to do their work well. Their price does not equal that of three tons of coal.

Houses heated by steam or hot water are, of course, free from coal-gas, unless the boiler-fire is so situated or managed as to turn it into the rooms; and, when the fuel used in a stove or furnace is bituminous coal, much less carbonic oxide is generated than from anthracite. Where wood is burned, the danger is altogether avoided; but from coke the generation of the oxide is abundant.

Open coal-fires are more free from objections, if they have clear flues and abundant draughts. Even then a certain amount of carbonic oxide escapes into the house under certain conditions of the atmosphere, especially when fresh fuel is added, or the combustion is sluggish. In rooms occupied chiefly by infants, therefore, wood-fires are very much to be preferred to any others. Soft coal is, of course, preferable to anthracite.

It is a well-known fact that carbonic oxide is found, in minute quantity, in the smoke of tobacco, — more abundantly, indeed, than Dr. Gustav Wolfhügel[1] has been able

[1] *Zeitschrift für Biologie*, xii. 696, and xiv. 506.

to find it in rooms heated with coal[1] by means of red-hot cast-iron stoves. In his opinion, there is not enough in a closed room filled with tobacco-smoke to do any harm, although there might naturally be a difference of opinion on that point. His recent experiments indicate that no appreciable quantity of carbonic oxide passes through red-hot cast-iron stoves, without seams or joints, unless the iron be of poor quality and more porous than it should be. Perhaps the different qualities of stoves and coal used for experiment, and a varying completeness of draught, may partly account for the discrepant results obtained by different investigators.

Persons who have become insensible from inhaling coal-gas should be treated very much as if they had been nearly drowned; i.e., they should be immediately removed to a pure atmosphere, and means taken promptly and *persistently* to establish artificial respiration. Friction should be applied to the extremities; and, if these measures are not speedily efficacious, a galvanic battery should be used in conjunction with them. The inhalation of oxygen under competent medical direction has proved of service.

1 In this case, anthracite was not used, but the common softer coal of Germany.

COMMON DEFECTS IN HOUSE-DRAINS.

BY

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COMMON DEFECTS IN HOUSE-DRAINS.

THE purpose of this paper is to state what are the common defects in house-drains, and to show the usual forms and condition of such drains as they exist in our cities and towns to-day. The statement is chiefly based on observations made in Boston while constructing intercepting sewers; but it is assumed that examinations in other cities and towns of the Commonwealth would reveal a condition certainly no better, and probably worse. Some testimony will be offered from those whose occupation has given them opportunities for observation; and, while it is not intended to cite exceptional cases of defective arrangement or construction, a few characteristic examples will be given, such as investigation would prove to be very common.

What are the essential conditions of an efficient house-drain, one or more of which must be violated to constitute a defect?

Briefly stated, they are, that the drain must be of size and shape to concentrate its flow, smooth inside, suitably inclined, tight, properly connected with the house-pipes and sewer, strong and durable in material. It is of great importance that the portion of the drain within the house should be always in such a position as to admit of ready inspection at any time; it *should be in sight*,[1] and not concealed. Let us see what proportion of Boston drains reasonably fulfil these conditions.

Existence is perhaps the most essential condition of a drain; and, by an Hibernicism, non-existence may be termed its most serious defect. Naturally non-existence was not

[1] The same rule applies, of course, to soil-pipes, although that part of the subject does not come within the scope of the present inquiry.

observed in digging for the intercepting sewers, but there is sufficient evidence that it is not unknown.

The writer has seen a case where a drain-pipe from a dwelling ran through the walls, and there ended: several similar cases have been reported to him; and another, where a block of six expensive houses, occupied for months with all the customary apparatus in the way of plumbing and waste-pipes in full operation, had no drains beyond the walls to the street-sewer. Such cases are rare, and generally reveal themselves quickly; but it is more common to find drains which are so solidly filled with earth, grease, and other matter, as to exist only in name, and which, for any good they accomplish, might just as well not exist at all. One, examined by the writer some months since, had apparently had nothing through it for years, the whole waste from the soil-

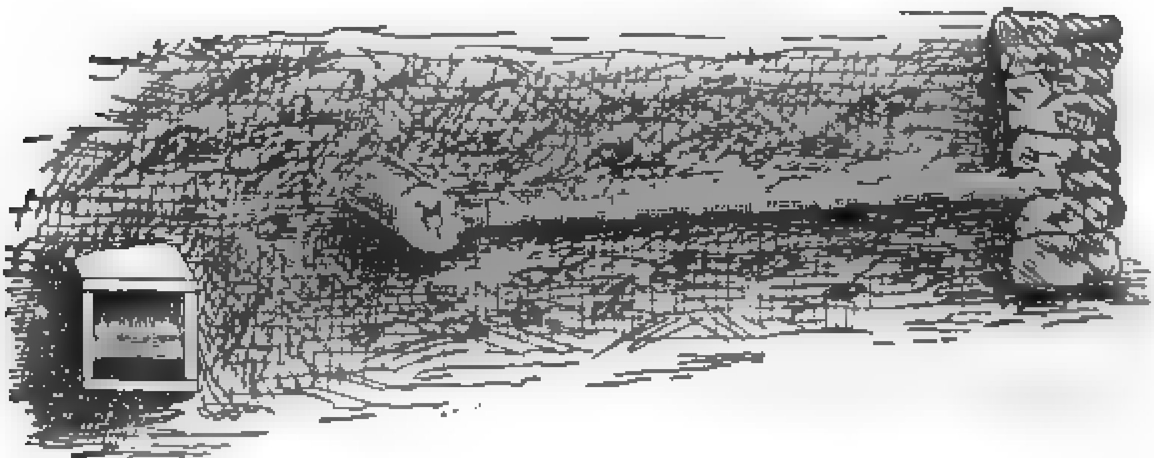


FIG. 1

pipe having accumulated beneath the cellar-floor. The same state of things was lately found to exist below the Rockland Bank Building in Boston. A case has been mentioned to the writer where it is thought that three deaths can be directly traced to the stoppage of a drain which was so clogged as not to act. Almost every one who has been led into this line of inquiry has some similar instance to relate, and evidence could be multiplied indefinitely. Of the house-drains crossing the intercepting-sewer trench, during its construction last season, fully twenty-five per cent were almost or entirely choked with sludge.

An example of *semi*-existence, observed while digging for the sewer in Charles Street, is worth noting, as showing the intelligent judgment sometimes exercised in doing this kind of work. It will be understood by referring to the sketch

(Fig. 1). The drain was one for surface-water; and the drain-layer, in digging from the house towards the sewer, came upon a log lying across his trench, and here stopped short, chopped a hole in the log, found it hollow, and connected his drain to it without going farther. It is true, the log led to no outlet, but then it saved trouble — to the drain-layer.

As to the question of size of drains, it was found that of 113 observed while building sewers the past year, —

11	were	about	4	inches	in diameter.
4	"	"	5	"	"
21	"	"	6	"	"
5	"	"	7	"	"
27	"	"	8	"	"
8	"	"	9	"	"
11	"	"	10	"	"
26	"	"	12	" or over	"

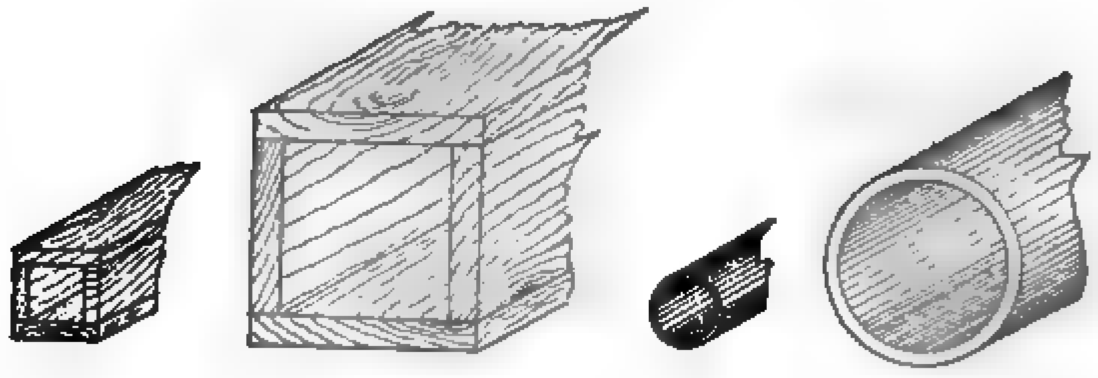


FIG. 2

The sketch above (Fig. 2) illustrates the wide range of this diversity. Most of them drained single dwellings similarly situated; and if the small ones were large enough the others must have been unnecessarily large, and *vice versa.*

But what is the proper size?

Probably nine engineers out of ten would answer, "By no means larger than 6 inches;" and nine drain-layers out of ten would now say, "Never smaller than 8 inches." The former argue that the drain need only be large enough to pass through it all that it can reasonably be expected to carry, and that any thing beyond this tends to make the ordinary flow spread thinly over a broad bottom, without sufficient depth to carry solid matters along with it. The latter reply, that, in fact, a drain never does receive only what can reasonably be expected; and that, the larger the

drain, the more storage-room for the unreasonable accumulations of clothing, tin and glass ware, dead animals, etc., usually found in it. "In practice," say they, "large drains take longer to choke up than small ones, and are therefore better."

Their facts are correct, but their conclusions may be doubted. In building a drain, the object should be to prevent the *beginning* of a deposit; and this is much easier

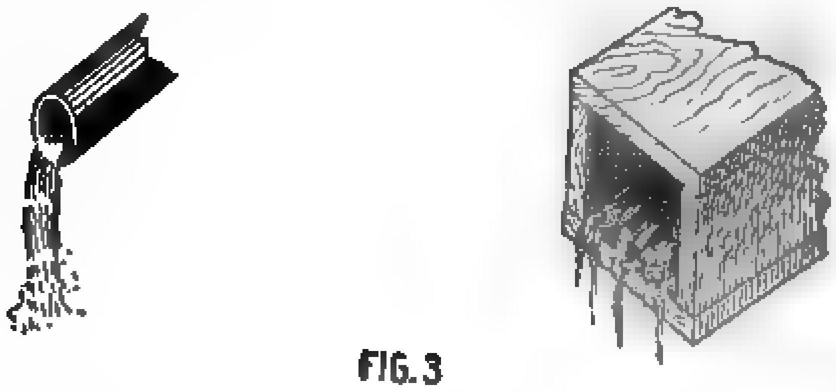


FIG. 3

in a small drain than in a large one, as will be understood from Fig. 3, where an equal quantity of water is supposed to be flowing in a 4-inch and a 12-inch drain. It might be thought (by one who thought at all about such matters) that the discharge of a great volume of water, as from a bath-tub, would tend to scour out and clean a drain. So it might a very small one. But in such a structure as our sketch

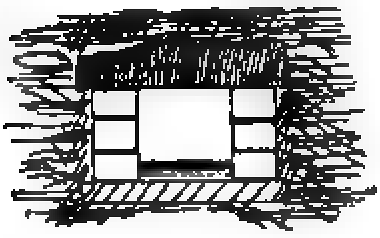


FIG. 4

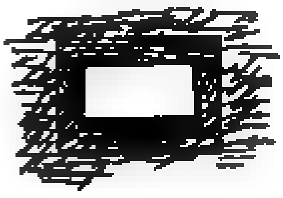


FIG. 5

FIG. 6

represents, with a flat bottom 12 inches wide, the stream caused by such a discharge would probably meander over the bottom of the drain, and be nowhere over a quarter of an inch deep. Let a deposit once begin, and subsequent accretions as surely choke a large drain as a small one, only it takes longer to do it. And it may even be questioned whether it is an advantage to be able to use for an additional year a drain nearly full of putrescent filth, or whether it is

not better to have the evil disclosed and remedied as soon as possible. It may safely be said that three-quarters at least of the house-drains in Boston are too large, because, even if some of them perform efficient service, small ones would do as well, and be less liable to get out of order.

In respect to form, there is almost as much diversity as there is in size. Figs. 4 to 10 give the more common shapes.

The first three must be condemned at once, on account of

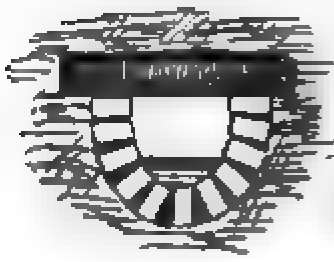


FIG. 7

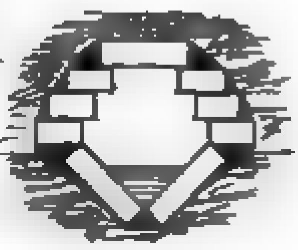


FIG. 8

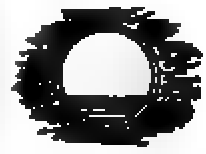


FIG. 9

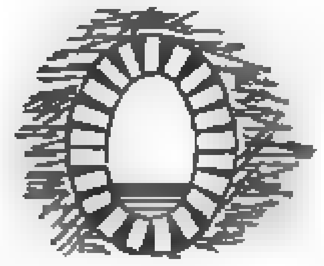


FIG. 10

their flat bottoms. The water passing through them spreads out into a thin sheet, which does not readily wash along solid matters. Floating matters also tend to stick in the angular corners more than than they would on rounded surfaces. That this is so, is shown by the record. Of the 113 house-drains whose condition was noted, 45 were constructed with flat bottoms; and of these, 26 were choked, or nearly so, with sludge; 19 were reasonably clean. Of the remaining 68, which

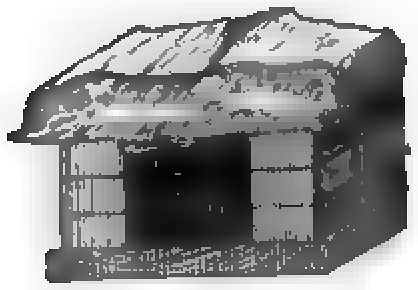


FIG. 11

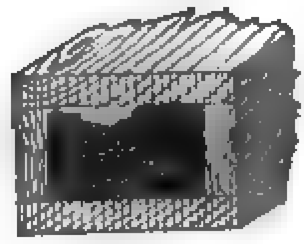


FIG. 12

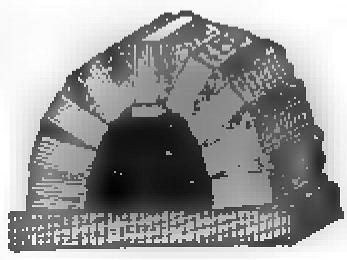


FIG. 13

had rounding bottoms, 12 were full, or partly so, of sludge; 56 were reasonably clean. The common appearance of these flat-bottomed drains, as they were uncovered, is shown in Figs. 11, 12, and 13. Fig. 13 represents the condition of a drain, now disused, which came from the City Hospital grounds.

The shapes shown in Figs. 7, 8, 9, and 10 are unobjectionable, although, in fact, these drains were often too large, and

had other defects. Fig. 8 is a kind of construction which was in vogue twenty-five years ago; and except for liability to open joints, its angular bottom, and its size, is passably good. Our facts seem to show that forty per cent of the Boston house-drains are defective in shape.

A drain should be smooth, so as to afford no prominences for solid particles to lodge upon. Planed wood, slate, and brick are smooth enough. In use they soon become covered with a film of slime that makes them very slippery. Un-

FIG. 14

planed wood, which until recently has been somewhat used, is apt to be rough, and to have splinters pointing against the flow, which catch solids moving upon them. The chief difficulty in making a brick drain smooth is the care required to see that no mortar is left projecting into the drain. Fig. 14 shows the manner in which such work is often finished.

It is possible to strike each joint of the lower half of the drain so as to leave a reasonably smooth surface; but a difficulty harder to avoid is caused by portions of the mortar

uniting the arch-bricks, falling when the supporting centres are removed. These lumps of cement, indicated in the sketch, adhere to the bottom, and, unless carefully scraped off, harden, and form serious obstructions to the flow of sewage.

Pipe drains, whether cement, clay, or iron, are smoother than those of brick. Glazed clay pipes are especially smooth. In these, however, it is very common to find the mortar uniting the several sections of pipe projecting into the interior, forming a series of little dams which obstruct the flow. Fig. 15 illustrates this. This can be avoided by carefully cleaning the interior of each pipe, after laying it, with a swab or hoe; a simple precaution, but often neglected by a careless drain-layer. It will not be an exaggeration to say that three-quarters of existing drains are defective as to their smoothness.

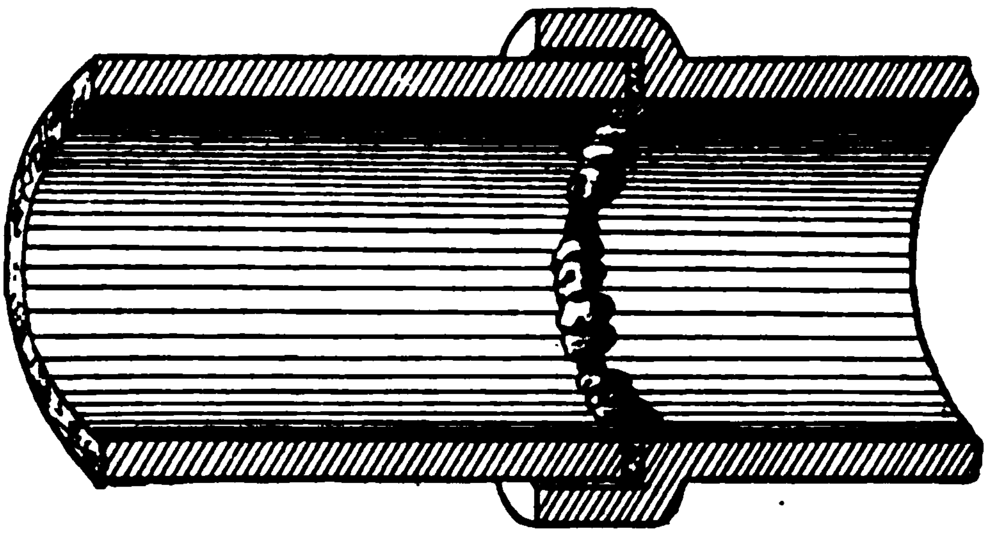


FIG. 15

The best rule in practice for the inclination of a house-drain is to give it as much pitch as is possible; and in few cases is less than one-half inch to the foot safe. A great many drains are faulty in this respect. The actual inclination of drains crossing the trench of the intercepting sewer the past year was not taken; but, of the 113 met with, 9 are recorded as level, and 14 as pitching the wrong way, that is, towards the house. One of these, coming from a public-school building, was about 7 inches lower at the street curb-stone than at the sewer. The condition of such a drain is shown in Fig. 16.

The water stands in the depressed portion of the drain to the height of its connection with the sewer; and, having little motion, deposits are apt to occur. In the case referred to, it is but fair to say that the school-drain was clean so far as seen. Very possibly an abundant use of water or recent heavy rains had scoured out any deposit that may have taken

place. It is probable that most of this inclination in the wrong direction occurs in the street, near the sewer. The drain-layer frequently begins to put in his drain simply with reference to the house, without inquiring what is the elevation of the sewer into which it is to empty. He digs his trench towards the street, and lays his drain on a slope which he judges by his eye to be sufficient. This in itself is a deceptive matter, as a trench generally seems to slope down towards the observer. When the sewer is reached, it is found to be higher than the portion of drain already laid. What is to be done? It is not the drain-layer's fault, that the sewer is too high; he cannot take the trouble to dig up his pipe again; it is only a few inches any way; and the pipe is run up and connected, the trench back filled, and, "out of sight, out of mind."

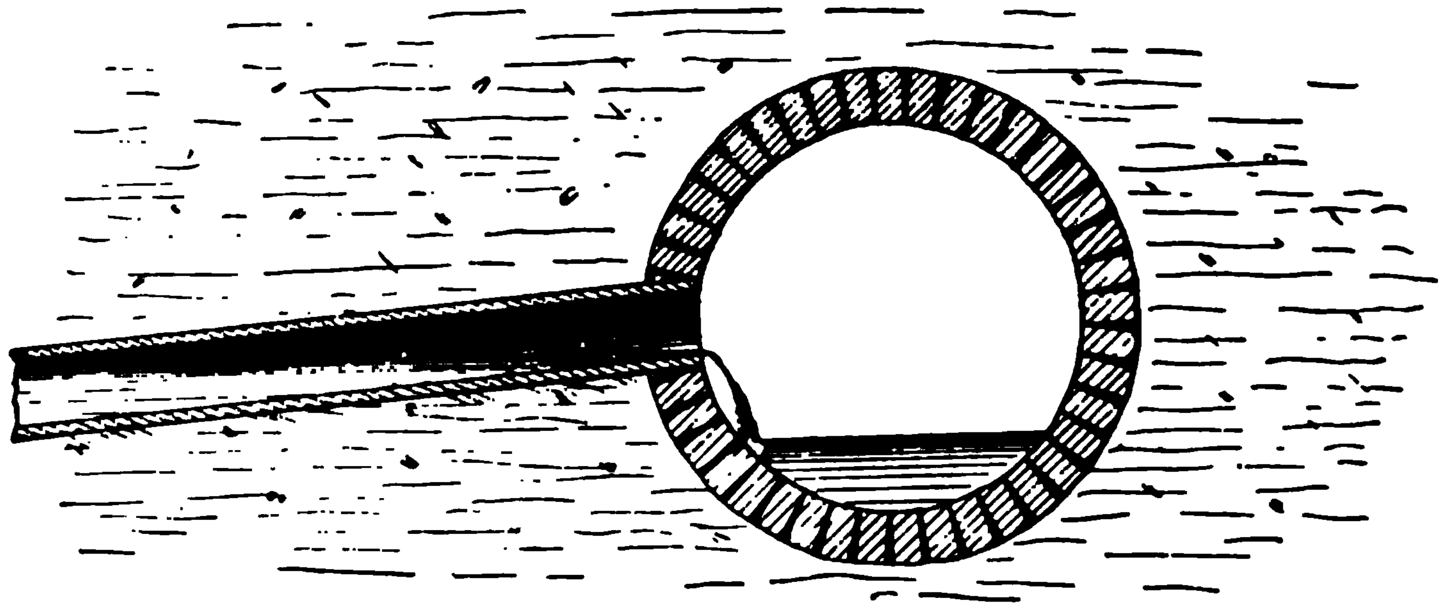


FIG. 16

It was stated that one of the essentials of an efficient house-drain is that it shall be tight. Mr. Ernest Bowditch has called the writer's attention to a condition in which, at first sight, a leaky drain might appear better than a tight one. He says, "It is sometimes noticed, where plumbing is from twenty to twenty-five years old, and where all the drains outside the cellar walls are of open stone (technically French drains), the soil-pipe not being ventilated, that there is no perceptible leakage of sewer-gas into the house. It is reasonable to suppose in these cases that the gas generated outside the house works up through the soil, rather than force the traps in the house. The modern method of tight drains and cesspools tends to drive all gases into the house. It is frequently more important, therefore, that recent plumbing should be ventilated, than that of older date."

Both tight and open drains tend to produce evils; but those arising from a tight drain can be obviated by proper ventilation of the house-pipes, while the evils from leaky ones are irremediable. Therefore we say, drains should be tight, that sewer-gas (or, what is worse, matters capable of producing sewer-gas during a long decomposition) may not escape; and also that the water may not leak out, leaving the solid contents of the drain stranded.

This want of tightness is the commonest defect of all, and probably three-quarters of the annoyance from drains is due to it. In the annual report of the Boston City Board of Health for the year ending April 30, 1878, is given the result of examinations of 351 house-drains in different sections of the city. Of these, 193, or 55 per cent, are reported as defective; and in nine cases out of ten the defect consisted in the drain not being tight. This defect, more than others, affects the better kind of houses.

Mr. Theodore Clark, who has had experience with this class of dwellings, speaks thus of earthenware and cement drain-pipes: "These, I think, rarely remain tight many years. Even where the drains are laid with the greatest care, I have observed that water will often, in course of time, make its way out around the joints between the pipe and the ring of cement. When broken it is found that the cement has taken a perfect mould of the pipe; but either from some greasiness, or possibly a little dust on the pipe at the time of laying, it has failed to adhere, and water has ultimately forced its way through. An accumulation of water caused by an obstruction in the pipes will often search out such places, which must have previously allowed gas to pass freely. Another very frequent source of trouble is the settling of the ground under and around the drain-pipes. In houses with drains originally in perfect condition, their joints will frequently in a year or two be found to be separated, the pipes cracked, or the branches settled away from the soil-pipes which enter them. In either case the drainage saturates the ground about the defective places with matter whose effluvium will penetrate even concrete.

"In my experience, defects of this kind are far more common than leaks in iron soil-pipes, imperfect traps, or other defects attributable to the plumber; and the earthen drain-

pipe should generally be first examined in searching for the cause of unpleasant smells in any part of the house, as effluvia originating in the cellar often find their way through furnace-pipes and behind furrings to the remotest corners of a building."

In this connection may be cited several cases recently reported, in each of which a smell was noticed whose source it seemed impossible to locate, until at last a leak was discovered in the drain, directly communicating with the cold-air supply-pipe of the furnace, which latter, of course, acted as a distributor of the gas through the entire house. A similar leak into the air-duct of the Boston City Hospital proved

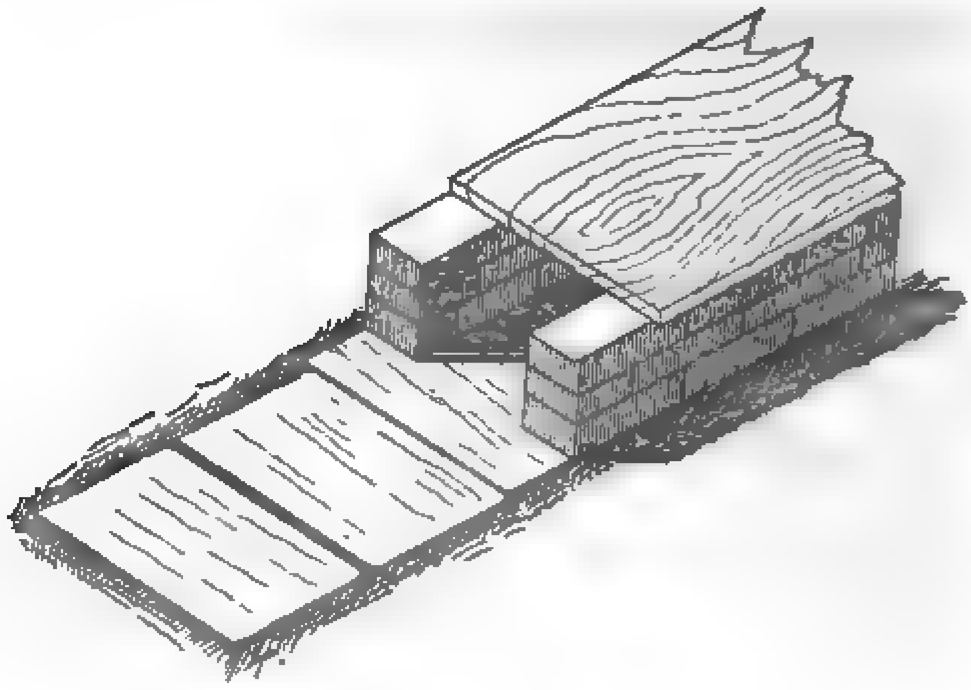


FIG. 17

a source of serious illness, and probably of increased mortality, among the surgical patients, until remedied in course of the various improvements introduced by Dr. Cowles.

Leaky drains are due to a variety of causes. In a brick drain the joints between the bricks may not be solidly filled with mortar, the mortar may not adhere to the bricks (a common result of not wetting the latter before laying), the bricks themselves may be shaky or rotten, or the structure as a whole may be broken by unequal settling. In some drains no attempt is made to have tight joints. A kind much built some years ago, and of which many examples remain, is shown in Fig. 17. In this the bottom is made of roofing-slates placed side by side, or sometimes overlapping,

but never with any thing to prevent water percolating through the joints into the soil below. Fig. 17 reversed, with plank below and slates above, would resemble more than half the drains on Beacon Hill as they were originally made, and still exist. A plank drain may leak through open joints, variously caused, through knot and nail holes, and by the rotting of the wood where it is not constantly wet. A pipe-drain may leak from bad joints, from flaws in the pipe itself, or because it has been broken. The breakage is generally

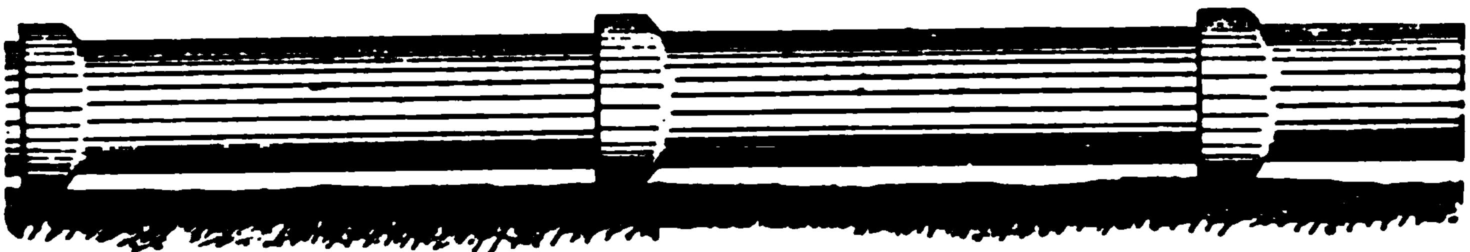


FIG. 18

due to unequal settling, sometimes to defective pipes, and occasionally to improper methods of laying them. The sections are sometimes carelessly or ignorantly laid on the bottom of the trench, resting merely upon their flanges as shown in Fig. 18, instead of upon their entire lengths, with depressions dug out for the flanges, as in Fig. 19.

In the former case, unless the dirt be rammed back beneath the pipe with unusual care, the pipe acts as a beam resting on supports three feet apart, and is liable to be broken by

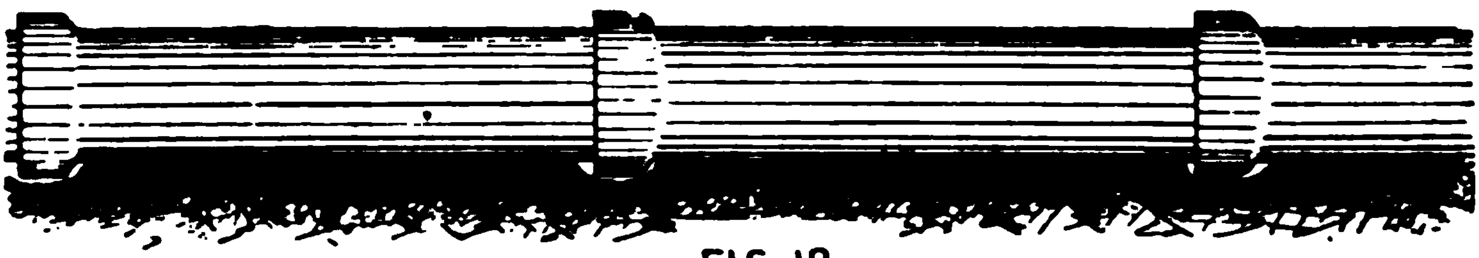


FIG. 19

the superincumbent earth, or by any shock as of a body falling, or a wagon jolting over it.

As the greater proportion of leaks are caused by defective joints, it follows that a brick drain with joints every inch or two is more liable to this defect than a clay or cement pipe with joints two or three feet apart, and that iron pipe in five-feet lengths is less liable to it. A place where a leak frequently occurs, especially in a house built on made land, is where the drain passes through the cellar-wall. If the

foundation wall is supported, and the ground on either side settles, a condition of things is produced shown in Fig. 20.

A drain may exist in such a state for months, or longer, without detection. The water follows the wall, perhaps into neighboring houses, saturates the ground in the vicinity, and finally finds an outlet through some pervious stratum or into some well. If the cellar be concreted, little moisture may be apparent, — an ill-defined odor to which the family become accustomed, and about which visitors feel a delicacy of speaking, being the only suggestion of trouble, — until finally, perhaps, may come some "unaccountable" sickness, or "mysterious visitation of Providence." Mr. W. H. Bradley,

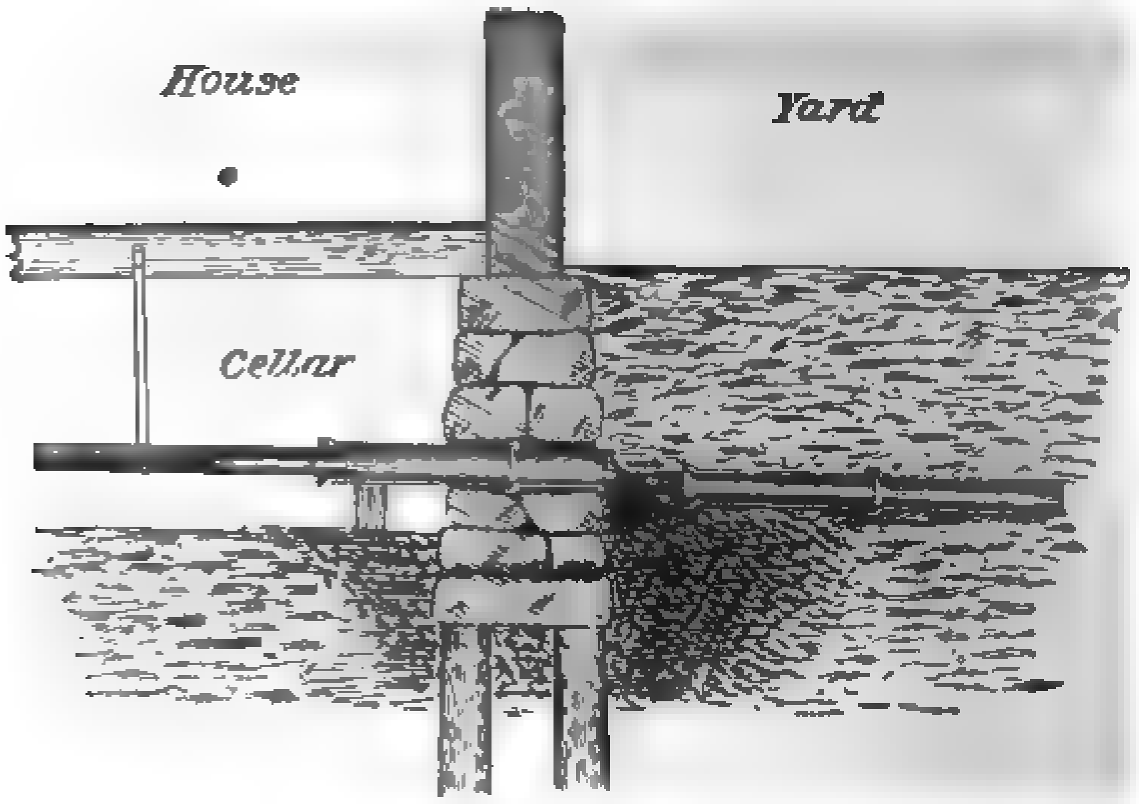


FIG 20

Superintendent of Boston Sewers, spoke thus of this matter three years ago, in a communication to the city government: "The number of drains leaking under houses and into foundation-walls is very large; it is almost certain to occur with every house upon made land, and is always neglected by owners and tenants till it becomes insupportable; and with sickness traceable to such causes, and continual discomfort prevailing, the parties most interested still wait for the city to carry out costly general measures, thinking thus to abate their private nuisance. As a rule, a bad smell in a house means something wrong locally, and should be stopped in a day."

The examinations of house-drains, before referred to, made by the Boston Board of Health, which aimed at the discovery of leaks by the use of strong-smelling volatile oils, show that more than one-half of Boston drains (and the proportion would probably not be less elsewhere in the State) are defective from want of tightness.

A drain should be firmly and properly connected to the sewer at one of its ends, and to the soil-pipe (if this connection be within the house, as it almost invariably is) at the other. More leaks probably occur at the latter place than at any other. The inspectors of the Boston Board of Health,

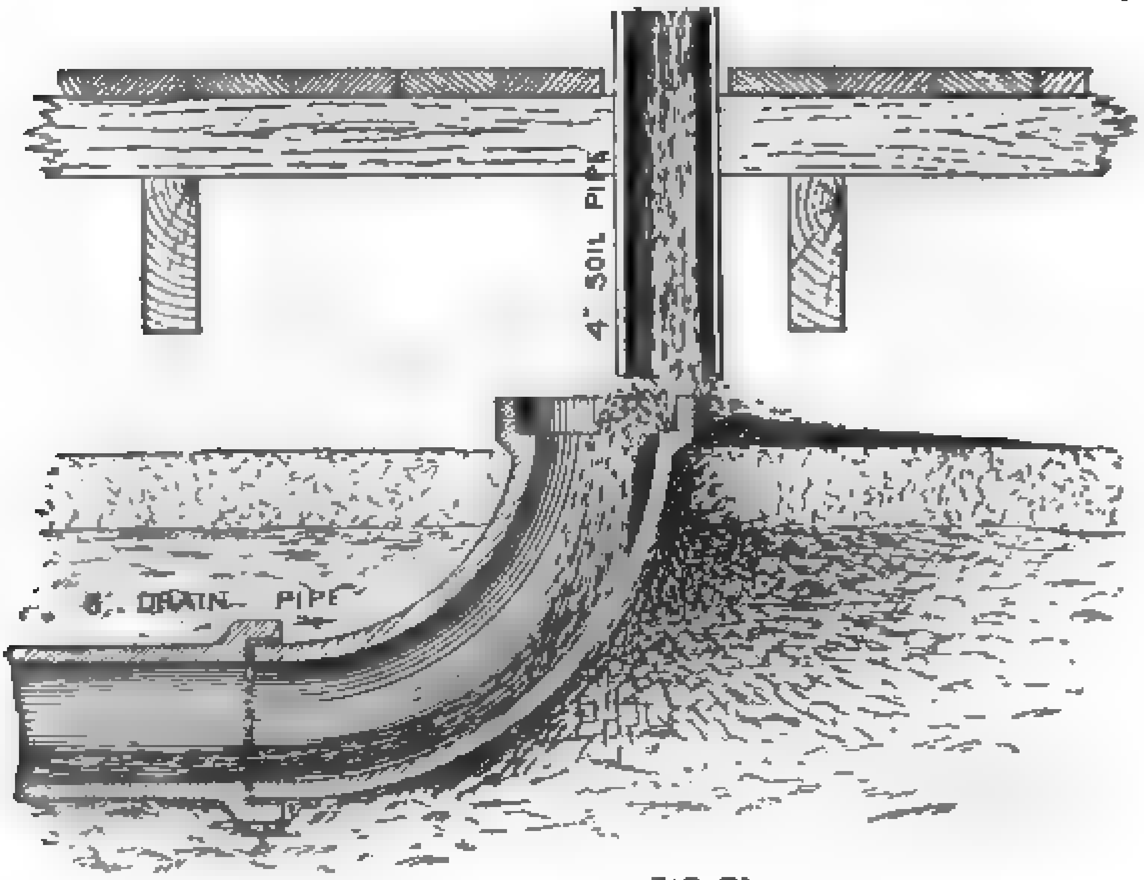


FIG. 21

after pouring a little oil of peppermint into an upper water-closet, most frequently recognize the familiar odor at this point. Sometimes there is not even a pretence of making a tight joint, the soil-pipe being merely inserted loosely into the drain. In other cases the joint, intended to be tight when made, through careless construction is not so; and again having been tight when made, it may have been injured since. Fig. 21 is from a sketch made by Mr. Bradley of a case brought to his attention, existing in the house of a Boston physician. The drain may settle away from the pipe, or the pipe may settle into the drain; an iron pipe by its

expansion and contraction may break the joint between them. So liable is this place to disturbance, that when possible it is well to build it so that it may be accessible to examination at any time when there is the least suspicion of wrong. Rats frequent drains, and dig into and out of them

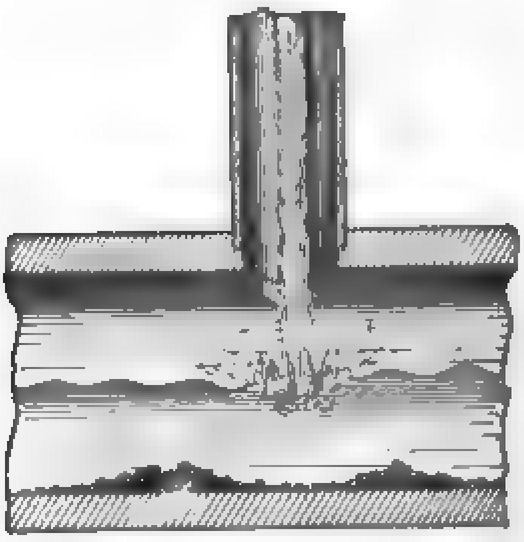


FIG. 22

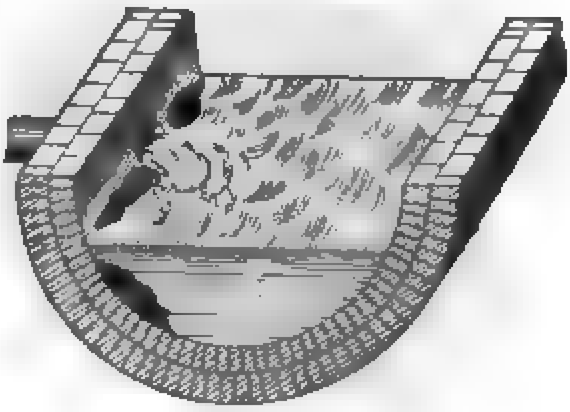


FIG. 23

with surprising facility. An influx of rats into a house should be taken as strong presumptive evidence of a defect in the drain.

The mode of connecting a drain with the sewer affects more the efficiency of the latter than it does directly the sanitary condition of the house. But as, indirectly, the condition of the sewer as to cleanliness, efficiency, and liability to generate gases, affects, through the drain, every house connecting with it, the proper junction of the drain and sewer deserves a degree of attention which till quite recently it has seldom received.

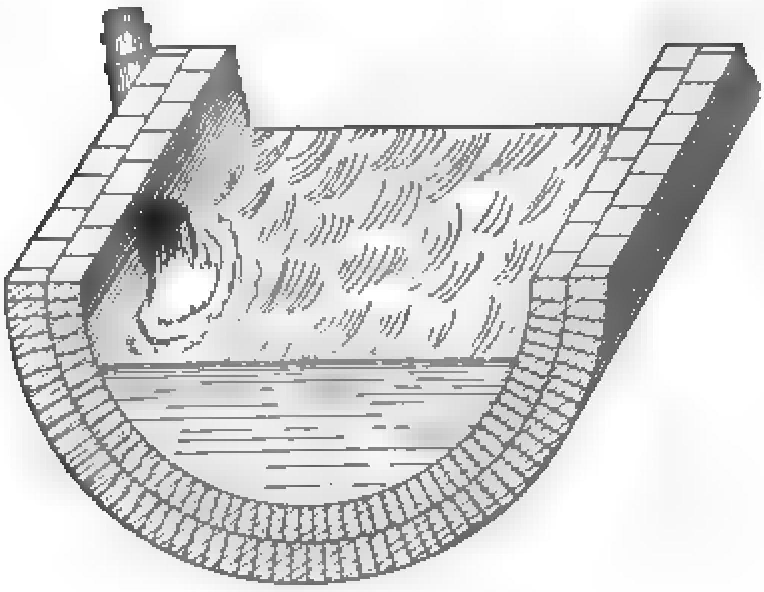


FIG. 24

A drain should enter the sewer either by a curve tangent to the direction of flow in the sewer, or at an acute angle with

that direction, so that the contents of the drain shall unite readily with that of the sewer, and the velocity of neither be much retarded. Nineteen out of twenty drains in Boston, built previous to 1876, enter the sewer at right angles. The effect of such an entrance from the top or side it is attempted

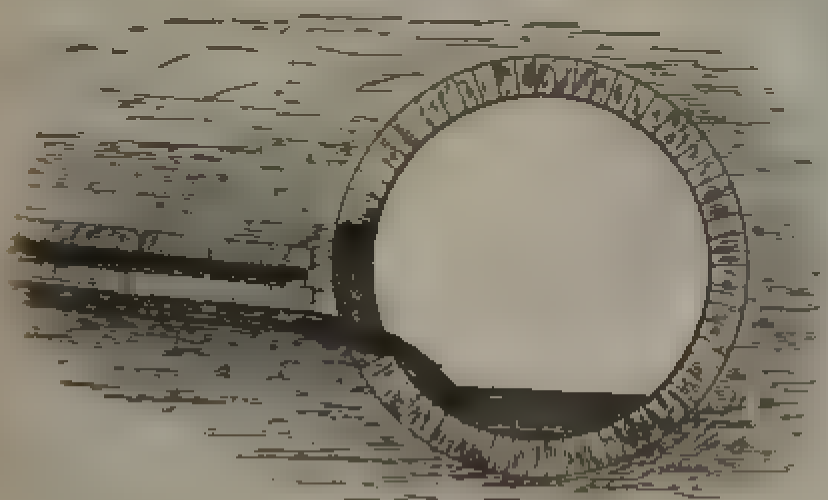


FIG 25

to show in the accompanying sketches (Figs. 22 and 23), where the tendency to arrest the flow in both structures, and to cause eddies and deposits, is shown in a somewhat exaggerated way. Fig. 24 shows the better result attained by connecting the drain at an acute angle.

FIG 26

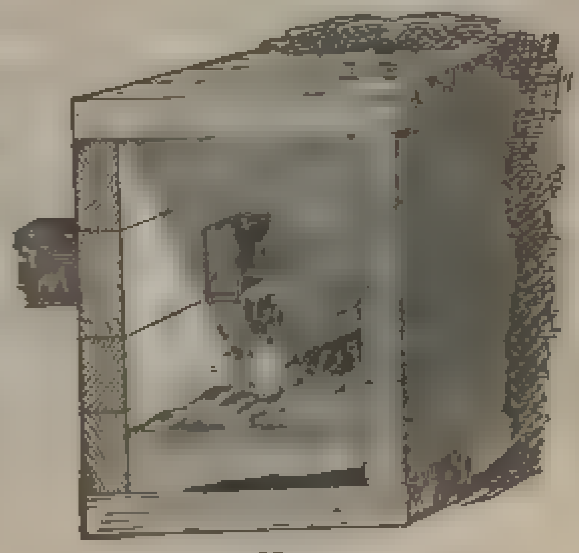


FIG 27

It will probably be conceded, that, whatever may be the mode of connection between drain and sewer, it should be made in a firm and workmanlike manner. In practice it has generally been very loosely and roughly made. Sometimes there is no connection at all, as shown in Fig. 25, where

the drain is simply brought pretty near to the sewer, and a hole broken into the latter. Of course water from both drain and sewer soaks into the ground, and occasionally the earth falls into them. Often, as in Figs. 26 and 27, a hole, somewhat too large, is cut into the side of the sewer,

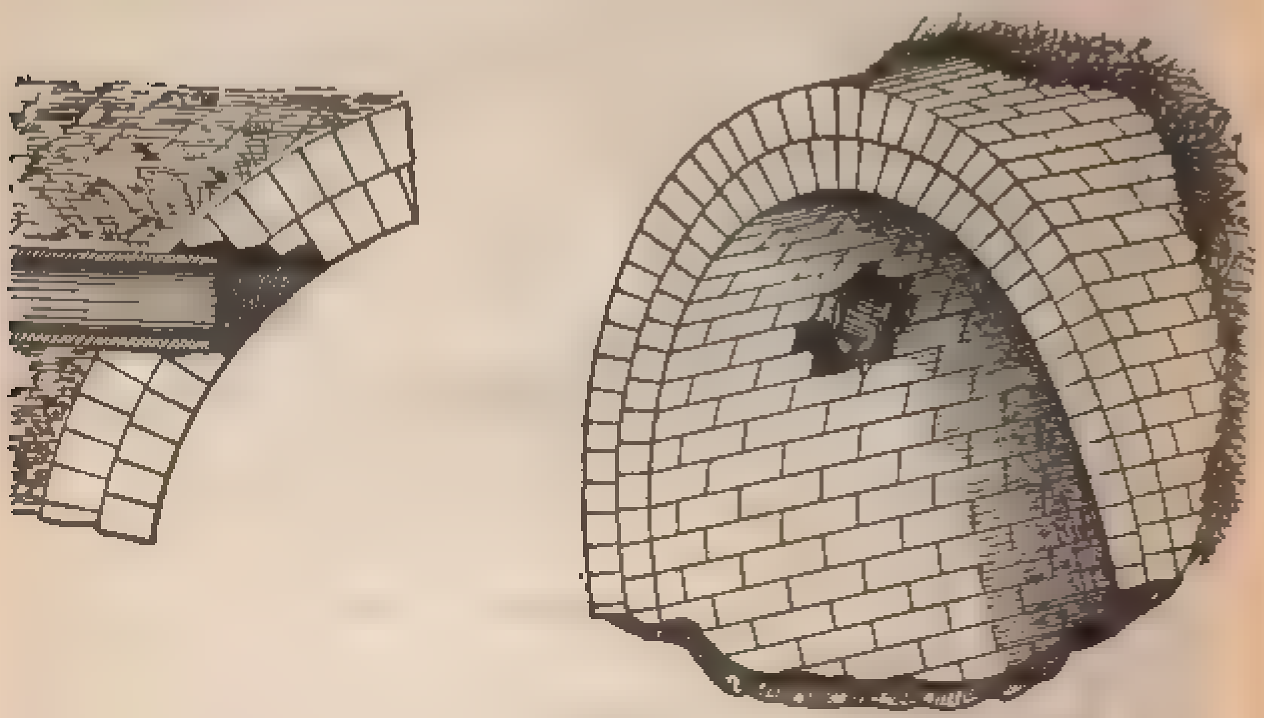


FIG. 28

and the pipe pushed through, and allowed to project more or less within the sewer. Fig. 28 shows the rough way in which pipes are often connected with the arch of a sewer.

The proper height in a sewer at which drains should be connected is about its ordinary flow-line. At this point the

FIG. 29

water from the drain mingles with that in the sewer with the least disturbance to both. In Boston, drains have commonly entered the sewers wherever they happened to run against them. As a general rule, they are too low (Fig. 29); and water from the sewer backs into them, making a sluggish

current. Their being too low might be expected from what was shown in connection with inclination of drains; and this results largely from an effort to drain cellars into a sewer higher than the cellar floors. Occasionally a drain-layer, having found a sewer much lower than he expected, has dug vertically to it, broken a hole in its top, and around the hole erected a chimney with which to connect his drain (Fig. 30). Often the hole into the sewer is much smaller than the drain which empties through it (Figs. 31 and 32). In such cases there are shoulders around the hole, on which solid matters accumulate.

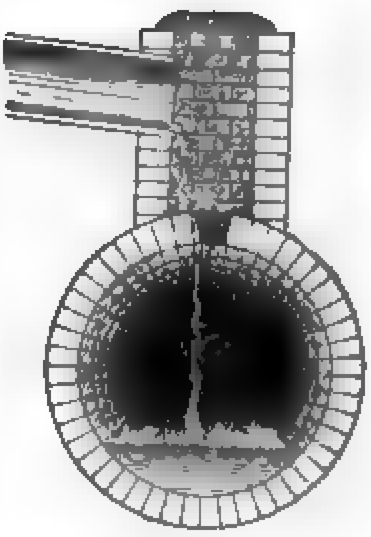


FIG. 30

The sketches that have been given exhibit what until very recently has been the method, or rather lack of method, of making connections with the sewers of Boston; and it is supposed that the manner of doing such work elsewhere in the State has been very similar. In Boston there has been an improvement in this respect during the last three years. The Superintendent of Sewers, realizing how much the efficiency of his charge was impaired by the way in which house-drains were frequently connected with the sewers, obtained, against considerable opposition, authority to require that any future connections should be made under his inspection. His regulations require junctions to be made with slants and curves, as shown in Fig. 33; but, of the total number of existing drains, the proportion so connected is very small. Speaking generally, it may be said that almost all the drains in old Boston are defectively connected with the sewers they enter.

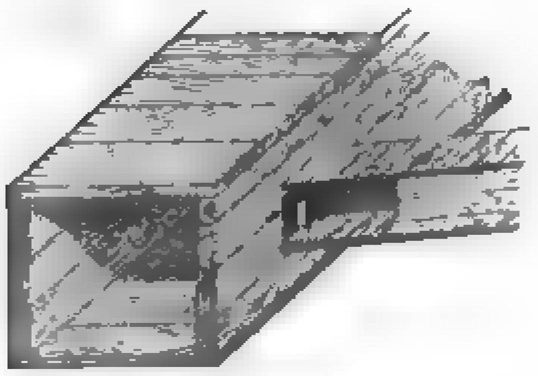


FIG. 31

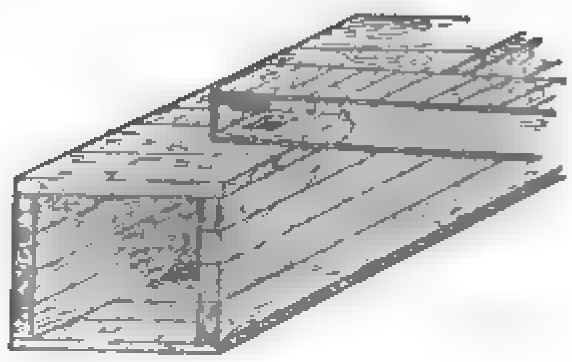


FIG. 32

The material of which a drain is composed should be durable, both on account of true economy, and, what is more important, because, being generally out of sight, any decay or failure in it is not readily discoverable. For the same reason that portion of the drain within the house should never be put where it cannot be easily examined in case there be any suspicion of trouble. The materials most generally used for drains are brick, stone, slate, vitrified clay, cement, wood, and iron.

Bricks made of good clay, thoroughly burnt all the way through, are among the most enduring of building materials.

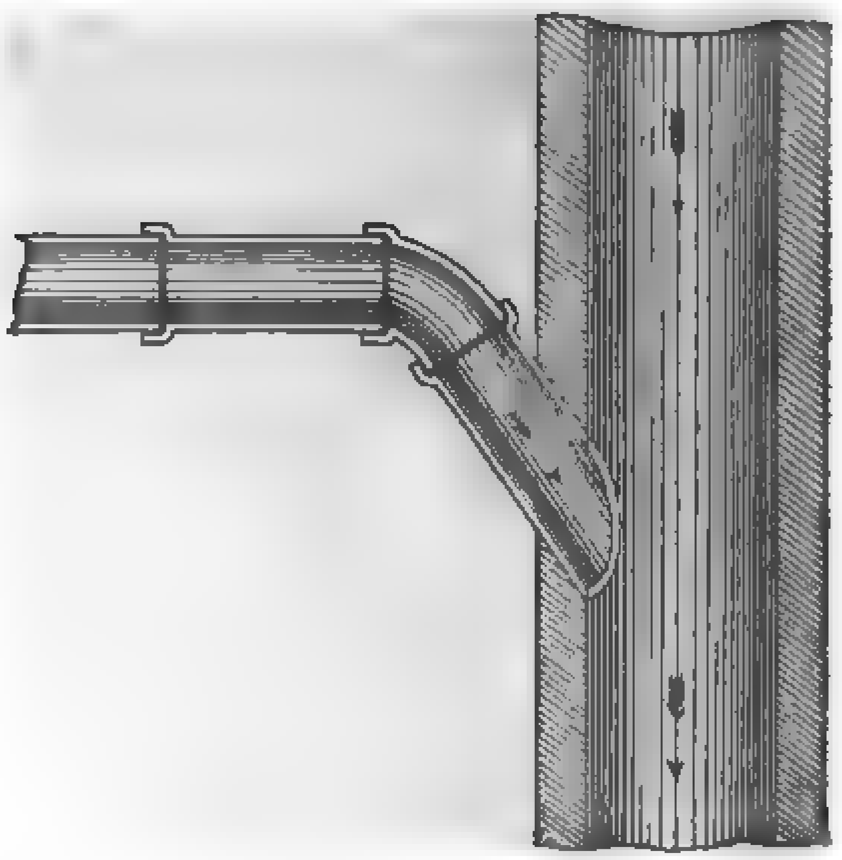


FIG. 33

But all bricks are not so enduring. From some kinds of clay good bricks cannot be made. In every kiln of bricks there are some which are not thoroughly burnt. A soft brick will rot and disintegrate in water. Therefore, while, as regards durability, bricks may be said to be a perfectly suitable material for drains, the statement is only true provided great care is used in selecting them. Building stone and slate, often used for the tops and bottoms of drains, are generally durable (though there are instances of slate disintegrating in the course of years); but there are other reasons why their use is not to be commended.

What has been said about bricks applies to the clay drain-pipe (now so commonly used), to a degree not usually recognized. Too frequently one hears Akron pipe spoken of as though it possessed unvarying qualities. It should be remembered that such pipes are burnt in a kiln very much as bricks are. Before burning they may be air-checked; like bricks, the pipes nearest the fire may be warped or fire-cracked; those higher up may be less thoroughly burnt, corresponding to "light-colored bricks." Others may be quite soft, and imperfectly glazed; or the glazing may scale off by "popping."

Slip-glazed pottery pipes are still more liable to defects. They are made of a different kind of clay, and, being burnt at a lower temperature, are usually more porous and less hard. The glazing, which is formed by dipping them before burning into a thin mixture of argillaceous earth, forms a skin over the pipe, which at times peels off under the action of frost, acids, or hard usage. While either kind of pipe, if well made, is durable enough, poor samples of each were occasionally noticed while constructing the intercepting sewer. It is important, that, in using them for house-drains, care should be exercised in their selection.

Without going into the vexed question of the comparative merits of clay and cement pipes, it is sufficient to say here of the latter, that while they can be, and often are, made so as to be very durable, yet cases where they have failed and disintegrated are frequently reported; and it is extremely difficult to judge from their appearance whether they are good or not. In resisting the action of acids and alkalies, they have been proved far inferior to well-burnt bricks or clay.

It is not easy to shape wood into the proper form for a drain. If it is always kept wet, as in the bottom of a drain constantly in use, it will last an indefinite time. Where it is alternately wet and dry, as in the sides or top of a drain, it is sure to decay sooner or later. Of those seen last year the report concerning many is, "rotten," "could not be held in place," "fell to pieces when handled," &c. The state of one such drain observed by the writer, in which the cover had partially rotted away, and earth fallen in, is given in Fig. 34. Unless there are exceptional conditions, the use of

wood for house-drains must be condemned on account of its liability to decay, as well as for other reasons.

The use of iron as a material for the construction of house-drains is of too recent date to permit of an absolute statement as to its durability. Thus far there seems little reason to doubt that it is suitable in this respect; and its many other merits will probably lead to its more extended use for this purpose.

Sanitary science, as it now exists, is of recent origin. Until within twenty years the arrangement and construction of sewers and drains were committed to mechanics and laborers, and were considered beneath the attention of educated men. Interest in the subject was first excited through the discovery by the medical profession, that a large class of diseases (thereafter called filth-diseases) was induced by the presence of gases arising from defective drainage.

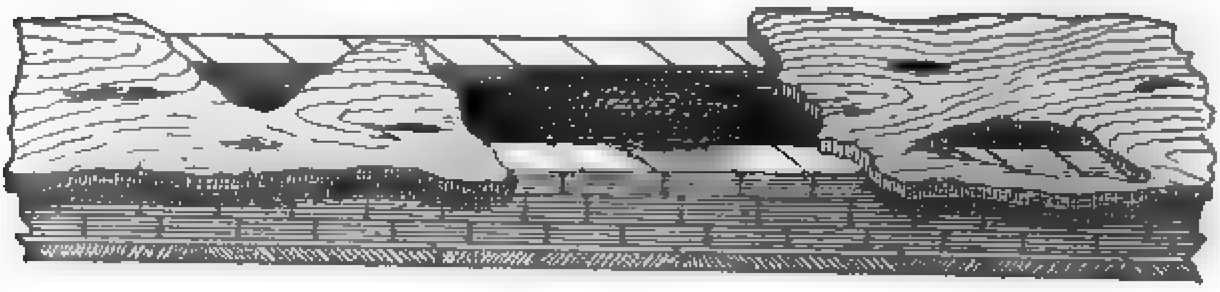


*FIG. 34

To investigate and cure the inefficient methods and appliances which caused these gases, lay within the province of the engineer; and hence sanitary engineering and sanitary engineers came into existence. These latter devoted themselves with ardor to unearthing evils, and devising remedies for them. Like new brooms they attempted to sweep clean, and to purify at once the Augean stables they had discovered. But, like all reformers, they were sometimes carried away by their discoveries and theories; so that occasionally public opinion has re-acted against an exaggerated presentment of the evils of bad drainage. People have replied, "Nonsense! things cannot be in such a desperate condition, or the human race would have died out. Our fathers lived comfortably to a good old age without bothering their heads about drains, ventilators, or traps; and we are willing to take our chances."

It might be answered that our fathers did not have our

intricate apparatus for drainage to bother themselves about. Neither did they put on double windows, and ventilate their houses through their cellars, nor connect their drains with their sleeping-rooms, as we do. The writer has no wish to be an alarmist. The risk from sewer-gas is probably not so great as many suppose: it is a slight risk, but a slight risk of a terrible danger. If a man thinks there is no need of insuring his house, because his father lived in it for fifty years without a conflagration, he has a right to his opinion. What has been given in this paper, beside a few general principles, is a simple statement of what exists as seen by the writer and others. The question of plumbing has not been noticed, because the writer is not especially qualified to discuss it. He merely speaks whereof he knows; and the evidence is submitted without argument, for the consideration of those interested.

Should any one, admitting the evil, ask concerning a remedy, the answer is twofold. For the defective drainage which already exists, there can probably be no immediate radical relief: it can only come as people learn to appreciate the danger of sickness and the value of health. When householders become sufficiently interested to wish to know where and what their drains are, and to make a few investigations with bottles of peppermint and otherwise, then will the better day be at hand.

As to what may be done to prevent an increase of bad work, a suggestion is offered. It is safe to assume that every man who builds a house for himself desires that its drainage shall be fairly efficient: unfortunately it is not equally safe to assume that he will spend the time, thought, and money necessary to make it so. Now, since a defective house-drain may affect not only the owner of the house, and his family, and all who may thereafter reside there, but also the whole neighborhood, would it infringe on personal liberty too much, to require that the house-drain, if no more, shall be built according to approved plans and under municipal inspection? Merely to require that before beginning such work a plan of it should be put on record, would accomplish something. In drainage, to have *some* plan, even if a bad one, is better than none. It insures a little thought beforehand, a knowledge of the height of the sewer, and an adaptation of the drainage to it.

In Frankfort-on-the-Main, which has lately been sewered on the most perfect system and with the latest results of engineering skill, it was found impossible to realize the expected benefits unless some control was exercised over house-drainage. In that city, connection with the city-sewers is not compulsory; but if any one desires, as nearly all do, to drain into them, it is required that detailed plans in duplicate, showing every thing to be done, shall be filed, one with the board of works for its approval, and the other to be kept at the house. The whole work is done subject to its constant inspection of materials and workmanship.

In the Eighth Annual Report of the State Board of Health, January, 1877, pp. 130–132, are given the conditions under which buildings, &c., are allowed to be drained into the new sewerage system of Frankfort. The plans to be filed are referred to thus:—

"Whenever the drainage of any house, yard, &c., is projected, the owner of the property in question must, after having signed the requisite certificate, furnish to the department duplicate plans bearing the signature of the contractor, and containing a map of the locality on a scale of at least 1:2,500, a ground-plan at least 1:250, and a sketch of the main drain and branches with its horizontal plane on the same scale as the ground-plan, and its profile at least 1:125."

"The certificate and one of the duplicate plans are to be kept among the documents of the sewer department: the other plan must be always ready for inspection by the officers at the place for which it is designed."

"All plans presented must contain all the works projected; the exact position of sinks, gullies, traps, and other details; the direction of the superficial water-carriers; the positions of the rain-spouts, cisterns, privies, water-closets, cesspools, vaults, wells, pumps, and other arrangements for water supply; also the levels of the surface where the works are projected, including the grades of the latter, the depth of the cellar, the lowest levels of the ground, and, where possible, the depth of the foundations,—all to be given by the standard grade."

This preparation of plans is the pivotal point about which centres the whole regulation of private drainage. Its effect is probably, that, as the owner and mechanic are unable to make the plans with the requisite nicety and accuracy, they are prepared by an engineer familiar with the proper designing of such structures. It will be noticed that this filing of plans is not to be a mere form, but that a duplicate is to be kept on the ground to be constantly referred to in constructing the work.

The question of sewerage is forcing itself upon the attention of all our cities and towns. Boston has appropriated between three and four millions of dollars for a system of interception, whereby its sewers shall discharge freely at all times, and their contents be diverted from the vicinity of dwellings. It is the first, most important step, and, as the tax-payers realize, costs dearly. If the full benefit of this improvement is ever to be realized, it will only be when the house-drains and common sewers are rendered equally efficient, and the fundamental condition of perfect sewerage — an uninterrupted removal of waste matter from the house to its final place of deposit — is attained.

REPORT OF THE EVIDENCE, ETC., BEFORE THE STATE BOARD OF HEALTH,

IN THE CASE OF

THE CITY OF CAMBRIDGE *v.* NILES BROTHERS.

INDEX.

15

PETITION.

To the State Board of Health.

Respectfully represents the City of Cambridge, a municipal corporation situated in the County of Middlesex, in this Commonwealth, that this Commonwealth has granted to said Cambridge, for the purpose of supplying said Cambridge and the inhabitants thereof with pure water for the extinguishment of fires and for domestic and other purposes, the right to take, hold, and convey into and through said city, the waters of Fresh Pond, a natural pond of more than twenty acres in extent, situated partly in said Cambridge and partly in the town of Belmont, in said County, and, to that end, the right to build, lay, erect, and maintain such reservoirs, pipes, drains, dams, and buildings as may be necessary for collecting, conducting, and distributing said waters through said city; that under said grant the waters of said pond have been distributed to the inhabitants of said city, and are in constant use by them for drinking and all other domestic purposes, and there is scarcely any other water used by said inhabitants; and that the population of said Cambridge exceeds forty-five thousand.

And your petitioner further represents that upon a lot of land situated in said Belmont, less than seven hundred feet from said pond, and bounded southerly by Concord Avenue, westerly by land taken by said Cambridge for the purpose of laying and maintaining a conduit from Little Pond to said Fresh Pond, northerly and easterly by land late of Frederick Tudor, deceased, there is a building, with several outbuildings, which is now occupied and used by certain persons, — to wit: Sullivan Niles, J. Harris Niles, Louville V. Niles, and Joseph Boynton, all of Boston in this Commonwealth, — for carrying on the business of slaughtering hogs and other animals, and for rendering and other noxious occupations; that said building thus occupied is a public nuisance; and that the public health, comfort, and convenience, and particularly the health of all persons who use the waters of said Fresh Pond, absolutely require that the said building should not be used for any such purpose.

Wherefore the said Cambridge respectfully requests that this honorable Board shall order the said Sullivan Niles, J. Harris Niles, Louville V. Niles, and Joseph Boynton, and each of them, to forthwith desist and cease from carrying on the business of slaughtering hogs or other animals, or of rendering, or from carrying on any other noxious trade, either by themselves, their agents or servants, or the agents or servants of either of them, in the aforesaid building or outbuildings upon said land.

Dated at Cambridge, this sixth day of December, A.D. 1878.

(Signed) CITY OF CAMBRIDGE,
By Sam'l L. Montague, *its Mayor*

REMONSTRANCE.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK SS.

Before the State Board of Health, in the matter of the city of Cambridge against Sullivan Niles, J. Harris Niles, and Louville V. Niles,— praying for an order from said Board to prohibit said respondents from carrying on a certain business on their premises at Belmont, and on which petition an order of notice has been made returnable this day, to wit, the twentieth day of December, A.D. 1878.

And now come the respondents, and in their own proper persons say that said State Board of Health ought not to take or have cognizance of the said petition, for that the subject matter thereof is not, at the present time, within the jurisdiction of the said State Board of Health, but is wholly cognizable by the Selectmen of the town of Belmont acting as the Board of Health of the said town; that said Selectmen have already taken and now hold jurisdiction of said subject matter of said petition and have full power and authority to issue any and all orders, whether of prohibition or regulation, that the interests of the public or the rights of the petitioners may require, and that the State Board of Health has not at the present time any power or authority in the premises. And these respondents protest against the entertaining of the said petition and all proceedings under it, and pray to be hence dismissed.

(Signed) SULLIVAN NILES *per* L. V. N.
(Signed) J. HARRIS NILES *per* L. V. N.
(Signed) LOUVILLE V. NILES.

CAMBRIDGE *v.* NILES BROTHERS.

THE hearings in the case of the City of Cambridge *v.* Niles Brothers were held at the State House on Friday, Dec. 20, Saturday, Dec. 21, Monday, Dec. 23, and Friday, Dec. 27. The establishment of a slaughter-house had been begun in Belmont, near the Cambridge line, and about seven hundred feet from the Cambridge water-supply (Fresh Pond), in August, 1878. After a complaint from the City of Cambridge, the defendants petitioned the Board of Selectmen of Belmont for the license required by law, and without which they could not erect their buildings. At the public hearing upon the question, it was held by the authorities of Cambridge that such works, so near Fresh Pond, would endanger their public water-supply. The following license, however, was given: —

LICENSE.

BELMONT, Sept. 10, 1878.

Consent and permission are given to Sullivan Niles, J. Harris Niles, and Louville V. Niles, co-partners doing business under firm name of Niles Bros., to erect, use, and occupy a building or buildings, for carrying on therein the business of slaughtering swine, and melting and rendering lard and other products of said slaughtering, and manufacturing fertilizers or otherwise utilizing said fertilizers upon the premises occupied by said firm in Belmont. Said premises are bounded northerly by Concord Avenue, westerly by land[1] of the city of Cambridge as taken by them for a conduit and in part by land of William Richardson, northerly and easterly by land late of Tudor, and easterly in part by a private way separating the premises from land of Heywood. Said Niles Bros. are not to create a nuisance, or corrupt the waters of Fresh Pond.

J. S. KENDALL,
C. F. LIVERMORE,
HENRY FROST, JUN.,
Selectmen of Belmont.

[1] Twenty feet wide on the line of the conduit, widening to fifty feet at the point marked C.

The points of inquiry were naturally six: —

1. Whether the business of slaughtering and rendering, including all its details, was so conducted as to avoid the escape of offensive matter into the surrounding atmosphere.

2. Whether the buildings were so constructed, and provided with proper drainage, as not to pollute the soil, and thereby the water-supply of Cambridge.

3. Whether the provisions for disposing of the drainage of the establishment were sufficient for securing the water-supply from danger.

4. Whether any nuisance would be caused by foul stenches, from the fact that the main drain discharged into a small brook with a sluggish current.

5. Whether the preparation of manure from the "soup" would be a source of offence.

6. Whether the soil would become contaminated so as to be a noxious, and thereby incomplete, filter-bed for that portion of the water-supply furnished by the Wellington Brook water-shed, or by the conduit A F,[1] which is supplied mainly from the ground-water.

The evidence with regard to these points is given in the following pages, as stenographically reported by Mr. Doane, and revised from the proof-sheets by the counsel and witnesses, so as to avoid all possibility of error.

Since the hearing, the Board have officially visited the establishment, and Messrs. Webster, Hoadley, and Folsom were appointed a special committee of investigation in the matter; and it was also arranged that the secretary should visit the place once a week. The following additional evidence has been brought out by their further inquiry: —

1. The well O[1] was lowered by the pumping necessary to construct the conduit A F.

2. On the fifteenth day of January, 1879, with nearly a foot of snow on the ground, the maximum temperature for the day having been 28° F. and the minimum 3° F., barometer 30.37, and relative humidity 47, about 1,500 gallons deposited on the muck had a deep red color, disappeared almost entirely within ten minutes after the flow ceased, without having produced any real thawing of the muck-heap, it having evidently soaked down between the frozen lumps.

[1] See the map.

3. On Jan. 22, there was quite an offensive odor of "soup" easily noticed about two hundred feet from the muck-pile. The day was warm for winter, the snow thawing.

4. With reference to objections of companies taking ice from Fresh Pond, and to the extent to which any impurity in water is removed during the process of freezing,[1] Professor Sharples made some experiments, the results of which may be found in the following table and remarks.

Analysis of Samples of Water and Ice, by S. P. Sharples.

[Results given in parts per 100,000.]

January 11, 1878.	Ammonia.			Solid Residue.		
	Free.	Alb.	Total.	Volatile.	Fixed.	Total.
Fresh Pond water . . .	.0128	.0192	.0320	3.00	9.00	12.00
" " ice . . .	.0060	.0075	.0130	1.50	3.50	5.00
Spy Pond water . . .	.0640	.0128	.0768	4.00	13.00	17.00
" " ice. . . .	.0064	.0064	.0128	1.50	3.50	5.00
Little Spy Pond water . .	.0160	.0226	.0386	4.00	7.00	11.00
" " " ice . .	.0050	.0060	.0110	1.00	1.50	2.50
Pond-hole at Slaughter-house near Fresh Pond, water .	0.352	.1472	.1824	10.00	7.00	17.00
Pond-hole at Slaughter-house near Fresh Pond, ice . .	.0060	.0090	.0150	1.50	1.00	2.50

"The depth of the water at the various places is about as follows: Fresh Pond 30 feet, Spy Pond 15 feet, Little Pond 20 feet, pond-hole 8 feet. The pond-hole was made by digging out the muck in the swamp back of Niles Brothers' pig-house (P). The water from the melted ice was in all cases perfectly clear. The water from the pond-hole, under the ice, was of a shiny wine-color.

"The ice was broken into small pieces, and placed in a wide-mouthed bottle, which was tightly corked, and kept corked until the ice had melted. The water in each case was taken from the same spot as the ice. The ice was taken by clearing the surface, then chopping out a sufficient quantity with an axe, and afterwards breaking a hole through the ice, when the water was dipped out, and placed in a demijohn."

These results of Professor Sharples have been subsequently confirmed by Professor E. S. Wood, who has also kindly given the following statement of impurities in ice examined

[1] See also an article by Dr. A. H. Nichols, p. 455 of the Seventh Report of the Board, in which severe intestinal disorder was shown to have been caused by the use of impure ice.

by him for Dr. R. Amory of Brookline. In the first case, the excessive amount of impurity may have been due to some local source upon the ice. A certain amount of sickness was thought to have been traceable to it. Nos. 3 and 4 were directly from the pond: Nos. 1 and 2 were delivered to houses.

Analysis of Samples of impure Ice, by Professor E. S. Wood.

[Results given in parts per 100,000.]

DATE.		NH_3	Alb. NH_3	Cl.	Inorg. Res.	Org. & Vol.	Total Res.	REMARKS.
Dec. 3, 1876,	Horn Pond . . .	0.0026	0.044	0.4	1.6	7.6	9.2	Very turbid.
Jan. 23, 1877,	Hammond's Pond .	0.0066	0.019	–	1.0	1.4	2.4	Much clearer than above.
Feb. 12, 1877,	Jamaica Pond Ice Co. .	0.018	0.016	0.2	0.4	0.4	0.8	Quite clear.
" 12, 1877,	" " "	0.026	0.016	0.3	0.4	0.8	1.2	" "

The following are the results of examinations of water from the conduit A F, taken Feb. 27, 1879, by Professor W. B. Hills, as illustrating its character, independent of any contamination from the slaughter-house: —

[Results expressed in parts per 100,000.]

	Ammonia.	Albuminoid Ammonia.	Chlorine.	Inorganic Residue.	Organic and Volatile.	Total Residue.	Hardness.
Manhole, No. 1 * .	0.0174	0.015	3.8	10.0	7.0	17.0	8°
Manhole, No. 4 .	0.0186	0.017	4.0	10.0	8.0	18.0	9°
Manhole, No. 5 .	0.020	0.010	3.8	13.0	10.0	23.0	10°
Manhole, No. 7 .	0.012	0.009	4.0	11.5	7.1	18.6	10°

* Counting from Fresh Pond toward Little Pond.

All had a slight acid re-action: Nos. 1 and 4 had a slight opalescent appearance, No. 3 contained a large amount of suspended organic matter, No. 4 was perfectly clear. There was no odor from any of the samples on combustion. A scum of apparently vegetable matter covered the water entirely in No. 5, and to a considerable extent in Nos. 1 and 4; No. 7 was free. The samples, in all cases, were taken at a point deep enough to avoid this scum.

ARGUMENTS AND EVIDENCE.

OPENING BY MR. HAMMOND.

Mr. Chairman and Gentlemen,—I appear here in the behalf of the petitioners, and in behalf of the City of Cambridge, in support of this petition.

It is important that the Board should understand, as nearly as they can, the exact situation of the matter, as shown by the map. Some of the members of the Board may have been there, but others may not, and I will explain the map. It strikes me and the people of Cambridge, that this case presents for your consideration features of the most extraordinary nature.

We claim that this slaughter-house, although not in actual operation as yet more than four or five weeks, has already come to be, so far as the atmosphere is concerned in that vicinity, a nuisance. We claim, and shall show, that the air around is full of this disagreeable odor, and that the establishment is a nuisance, in the sense in which you have most often had occasion to consider these matters,—that is, that it is so carried on that it poisons the atmosphere, and that it is so situated that it can't be otherwise carried on. That is the general ground upon which you have proceeded, "That as ——— was injurious to the health," &c. And you have been sustained in it by the courts, and have judged these things to be nuisances, and that the owners shall be ordered to desist.

But there is another feature which looks to me to be more important, and which, in the interest of health, would seem to be of the utmost importance, namely, that this slaughter-house is near a pond of nearly two hundred acres in extent, which has been used for a great many years as a water-supply, and the inhabitants of Cambridge have adjusted themselves to that state of things, those of them that have ceased to use wells; and it may be said substantially, that the people of that large city of fifty thousand inhabitants are all dependent for their water-supply upon that pond; that, if it should become deteriorated so as to be unfit for use, that large city would be put to extreme peril. I don't care to dwell upon that feature of the case, at this stage of the hearing, but place it before you as one of the reasons why we come to you. I reserve further remarks upon this until the closing argument.

It seems to me, that you have arrived at a stage in this matter, at which it is important for you to show the same decision and energy that you have shown in like circumstances. It does so happen, I believe, that this is the only hog-slaughtering establishment, of any great magnitude,

that has been located where it cannot get drainage, and is situated under circumstances similar to those in which you found the slaughter-houses in Brighton in 1869. You have now got them so that they carry on their business as it should be carried on, and you are sustained by the Commonwealth.

Now you come to hog slaughter-houses. They have hitherto been located on Miller's River, and so placed that they empty into a sewer from eight to eight and a half feet in diameter. I don't know of any larger sewer in New England: it has been extended so as to meet the strong tidal currents of Charles River at Craigie's Bridge; and that is where they are located, — six slaughter-houses, I believe. It is questioned whether hog-slaughtering establishments ought to remain there, even with the great sewer as large as it is, and going to the deep currents as it does.

Now, here in Belmont is an attempt to go back to the system of 1869. An attempt is made to locate a slaughter-house in that swamp, with no means of drainage. You find these people in the same position in which you found the butchers of Brighton in 1869. I will read a few extracts from your own reports, to show how similar are the circumstances in all essential particulars.

In your first annual report, p. 23, after giving a graphic description of the filthiness of the slaughter-houses then existing in Brighton you use this language: "The floors of the slaughter-houses are of wood, and are saturated with blood. In most of them there is no sewerage; generally an imperfect drain leads to some marsh or low piece of ground, sometimes to a brook." That is an exact description of this slaughter-house, so far as the situation or outside of the building is concerned. "Generally an imperfect drain leads to some marsh or low piece of ground." A more accurate description of this slaughter-house in Belmont could not be given.

If this slaughter-house be allowed to go on, other slaughter-houses will go there, and you will have upon the banks of Fresh Pond exactly the same state of things, and it can't be avoided, — the same state of things you had among the butchers of Brighton. And I say that that is the place for your labors, and that the state of things is one which calls upon us all to pause, and take a *résumé* of the history of these matters, and see whether the people who have been going on here can be relied upon to meet the demands of health. [Refers to report in regard to the slaughter-houses in Brighton, in 1869.]

It was well known to all the members of this Board, that the first thing to be done was to arrange those slaughter-houses in Brighton, and as regards the slaughter-house itself (I read from the 32d page of the first report), "the essential things seem to be, —

"First, a pavement of stone, or of some material impervious to blood;

"Second, an abundant supply of water;

"Third, complete drainage and sewerage."

And this view has been confirmed by the subsequent experience of this Board. In the third annual report, p. 226, after reciting the above conditions, we find the following language: "In looking at the above

conclusions in the light of two years' experience we believe they are correct." And upon p. 242 of the same report we find this language: "As regards slaughtering, whether at Brighton or elsewhere, there are needed . . . abundant water-supply and drainage."

When it became known that you were about to do something about those slaughter-houses in Brighton, the butchers on the 8th of June made propositions to this Board, from which I quote as follows: "The improvements in the slaughter-houses comprise the laying of tight floors, of materials impervious to moisture, and the giving of these floors the required inclination to shed the blood, water, and other matters into suitable vessels provided for the reception and daily removal from the premises. The vessels will be made of material impervious to moisture, and kept perfectly clean and sweet. They are providing also for the use of a sufficient supply of water for cleansing the floors and vessels, and the most efficient antiseptics and disinfectants, as supplementary agents of purification. Of these, carbolic acid, chloride of lime, sesqui-chloride of iron, and lime, will be chiefly relied upon; and these articles will be employed faithfully."

How were these propositions received? "These proposals" (I quote from p. 238 of the same report) "met with no favor from the Board. The radical defects in the propositions were as follows: First, The impossibility of draining the present slaughter-houses," &c.

I say to the Board, then, in appearing before you, we show to you the state of things, identical with the state of things in Brighton, so far as every thing outside of this slaughter-house is concerned. I grant that that building has been constructed better than the slaughter-houses in Brighton. So far as the building itself is concerned, it is perhaps in as good condition as such buildings usually are. We object to it upon its radically bad situation. There is no such thing as proper drainage in that locality; and we make precisely the same objection which this Board made to the proposals of the butchers in 1872. We say we can't rely upon promises, because, in the first place, the promissors don't generally know what they want, themselves.

We first knew about this building about the 1st of August, 1878. We heard rumors along the latter part of July, that there was somebody up there, surveying the ground for a slaughter-house. We had had some trouble with Mr. Heywood, the owner, who had tried to induce us to buy the land, and we supposed this was a part of his plan. We supposed that they would be obliged to go ahead legally; and we couldn't believe it was any thing more than a scare, to make us buy the land. But about the 7th or 10th of August, such information came to Mr. Carter, as led him to believe that a slaughter-house was seriously contemplated there. We ascertained that they hadn't made a request of the selectmen of Belmont, for permission to build it. They had already built a part of the foundation, and the Tudor Ice Company sent us word, to know whether we couldn't exercise our powers to stop it. It was not within the bounds of Cambridge: it was in Belmont. We then had a hearing before the City Council; and Messrs. Niles and Boynton appeared, and stated that they didn't intend to hurt

anybody, and that they should use all the precautions necessary, and said, in the first place, that the desire was to neutralize the bad properties of their "soup," by chemicals. But they couldn't find chemists to recommend it. Well, then their idea was, as they slaughtered in the second story, to run that matter off by gravitation, over on the hill, in this direction (referring to the map). We asked them if they had got permission to do that, and it appeared that they hadn't. The only thing there would be in the drain-pipes was to be harmless liquid.

We then went before the selectmen of Belmont. Well, up there in Belmont they petitioned for a right to erect that slaughter-house, and said at the hearing that the reason why they hadn't before petitioned was because they didn't know it was necessary.

Mr. Warren, interrupting, stated: They said they had got verbal permission from the secretary, and didn't know that the passage of the law extended to towns of less than four thousand inhabitants.

Mr. Hammond resumed: The selectmen had told them it was not their business, until they began to make a nuisance. We went up and saw their chairman. We asked to be notified, and were heard. At that hearing, the plans seemed to be different from what they now are,—entirely different. Nothing was said about their taking the "soup" pipe across our conduit; but their whole plan was to get off as far as they could from it. Nothing was said about forcing their washings, etc., through the drain-pipe, but they were going to do it by the force of gravitation. They thought the height enough. Nothing was said about putting that pipe within two or three feet of the water-conduit. They said they were going to mix their "soup" with muck. We asked them if they considered how it would act in cold weather; and they had no answer to make to that proposition, although in four months of the year the ground is frozen here. Nevertheless, although we strenuously objected, and presented considerations that ought to have controlled the selectmen of Belmont, they granted that permission upon the ground that, if a nuisance was created, we could come to the State Board of Health.

It was apparently bringing taxable property into the town, and they easily saw that Belmont was not so much interested as Cambridge; and the permission was granted, on the ground that if a nuisance was created the State Board of Health had power to take care of it, and would do so. After that, the building was constructed and energetically pushed forward, and about four or five weeks ago they began to slaughter there. They say that they can slaughter from four hundred to five hundred hogs per day. They say that they don't intend to slaughter more than from two hundred and ten to two hundred and fifty; but, if the business is profitable, they will slaughter more largely. Now, since they have been going on, we can show you, in the first place, that they have carted from those premises, to premises in Belmont, portions of the offal of the hog. We can show that their drainage-pipe has leaked in large quantities, within two feet from the conduit. Offensive matter has leaked out from the pipe. We shall show that the drainage-pipe, which was not to have in it any offensive matter, has had in it matter the most

offensive to the nostrils and to the eyes, — reddish, as though of blood, showing that it has been stopped up, and didn't work, didn't carry the matter off, but has left it upon the marshes themselves. We shall show to you, by experiments, that the water, undoubtedly under the very side of that slaughter-house, goes into Fresh Pond by the conduit; that it would naturally go into Fresh Pond, but that it is accelerated by going in through the conduit. We shall ask you to look and see whether you can discover any way in which that business can be carried on satisfactorily to anybody, so far as that water is concerned. I only speak of these things to explain to you that we can't rely upon promises.

Experience shows, of men engaged in this business, that their sense of what is due to the demands of the public health is somewhat blunted. We ask you to apply to this situation of things exactly the rule which is applied satisfactorily to the condition of the beef-slaughtering establishments, as it was in Brighton in 1869; and that same state of things exists here as there.

EXAMINATION OF WITNESSES.

WILLIAM POLAND. — *Direct Examination by Mr. Hammond.*

Q. Your business is that of a sewer contractor? — *A.* Yes, sir.

Q. Did you build the conduit shown on that plan? — *A.* I did, sir.

Q. Do you remember when? — *A.* I could not say when. I think, in the year 1875 or 1876.

Q. As to the character of the soil? — *A.* The natural soil from here to here [A to B, referring to map] is mostly very coarse gravel.

Q. And will you state whether or not the water was plenty there? — *A.* The water was very plenty; I had two pumps, and could not draw it down; I had to pump in short sections.

Q. Water seemed to circulate very freely into the trench? — *A.* Yes, sir.

Q. How many pumps did you have as you were laying that? — *A.* I believe, two at one time.

Q. What was their capacity? — *A.* I could not say, very well: they were ordinary ones; one was a five-inch, and the other a four-inch.

Q. Did you keep them pumping night and day? — *A.* No, sir: I pumped during the day-time, and a short section at a time.

Q. How large was the section? — *A.* That depended on the section. We had a great quantity of water all through here; I had great difficulty in getting our timber bottom down.

Q. Water came in so fast? — *A.* Yes, sir.

Q. Is it coarse gravel? — *A.* Very; part of it is very coarse.

Q. What part of the conduit is of wood? — *A.* All the lower part.

Q. The bottom is of wood? — *A.* Yes, sir; two-inch plank, covered with an inch board.

Q. Is that water-tight? — *A.* No.

Q. Couldn't make it so? — *A.* No, sir; it takes a tremendous amount of water from the soil surrounding it.

Q. What is the character of the soil as you proceed toward Wellington Brook? — *A.* My own idea is that we struck a hard layer of mixed clay [at B], impervious to water, and that there we found our two waters entirely divided, with any quantity of water on either side of it. I believe the dividing ridge of hard clay, just beyond the second man-hole from Fresh Pond [B], to be the top of the clay bed underlying that pond, as it is apparently the same clay that we find on the other side of the pond. We strike it nowhere between this point [B] and the pond; and it pitches from there downward towards Fresh Pond, and also in the opposite direction towards Spy Pond. At the time of putting in the conduit, it divided the water in the gravel on the north end from that on the south or Fresh-Pond end of the conduit.

Q. How is the soil, as you proceed from the ridge to the brook? — *A.* At about the top of the hill [C], we found very fine sand, but, below that sand, very coarse gravel; we could only draw it down by taking short sections, and pumping over into the conduit; then, as we came over into the brook land, we struck clay [at D], and found no more water till we came to the brook. I noticed, the spring before we went there, the water stood very near the surface of this lot.

Q. How much below the surface did you have to go, as it now stands, before you get to water? — *A.* I should judge you might have to go down about five feet, or less. Mr. Carroll can tell better.

Q. Who is Carroll? — *A.* Carroll was the superintendent. I would go away, and leave him in charge of it.

Cross-examination by Mr. WARREN.

Q. I understand this is an eight-inch arch, is it? — *A.* Yes, sir.

Q. It was not a part of the calculation, when you built that conduit, to drain the soil, was it? — *A.* I don't know: I simply executed the calculations according to specifications.

Q. While you were digging the culvert, did the water run into the pond from this point? (B, referring to map.) — *A.* Yes, sir.

Q. And it ran the other way? — *A.* Yes, sir.

Q. No great flow? — *A.* We made a great deal of water there.

Q. I mean, there was no great fall of water in that direction, was there? — *A.* That connects with that drain along the railroad track, or Alewife Brook.

Q. Take the railroad to the line of your conduit here, and in the direction which the conduit runs, there was how much fall of water in your trench before the conduit was filled? — *A.* I don't think the water came off in this direction.

Q. Not following the line of the conduit? — *A.* No, sir.

Q. Now, that conduit carries the water from Little Pond to Fresh Pond? — *A.* Yes, sir.

Q. What is the whole fall from one pond to the other? — *A.* It is very scant, about three or four inches: it lies very near water level.

Q. Did it fall any more rapidly into the pond from this point (re-

ferring to map) than the whole way? — *A.* No, sir: there is a steady grade the whole way.

Q. I don't quite understand what you mean by saying that where you find that clay bed, the shore of the pond used to be: you don't mean that? — *A.* Yes, sir.

Q. There was a high hill there, wasn't there? — *A.* I know there was; but it was apparently all gravel; you met the same clay there as you did on the other side.

Q. You mean the underground shore of the pond? — *A.* Yes, sir.

Q. Hill thrown up? — *A.* Hill thrown down.

Q. You don't imagine it was carted in? — *A.* I don't know; but I think it was formed there.

Q. And the whole pond had been filled up at some time? — *A.* That portion of it; yes, sir.

Q. I suppose you account for it by some force of nature? — *A.* Yes; and, when we struck hardpan on both sides, we should claim they were both the same.

Q. You don't come to clay anywhere that [1] side of the pond? — *A.* No, sir: except a short distance, perhaps twenty to fifty feet [near B].

Q. I mean, on this [1] side? — *A.* No, sir; that is all gravel beds.

Q. All the way, it is gravel? — *A.* Except one spot [B] which is not: the most of it is of gravel varying in coarseness; the deeper I went, it appeared to be coarser gravel as it washed out.

Q. Do you mean to say, as a builder of this class of work, that you cannot build a conduit so that the water won't soak through it? — *A.* I mean to say that a conduit cannot be built on that plan, that will be water-tight.

Q. You can do so, if you want to? — *A.* Very seldom it is done.

Q. Then you consider the water in those marshes all good enough water? — *A.* There is no marsh in this gravel bed.

Q. Don't you go through any low land here [2]? — *A.* We go through clay; in that place we came to nothing else. All the way to Little Pond we got nothing around our conduit section, but gravel, sand, or clay; but there is a sand-hole or bog, on the edge of the upland.

Q. Then I understand that the water which drains into this conduit drains in through gravelly land, or sand? — *A.* Yes, sir.

Q. Where does the water come from, that drains through that gravel or sand? — *A.* From natural springs.

Q. Is the top of the conduit below the level of the swamp? — *A.* Along at the border of the swamp we did not have a very deep cut; we had to embank it somewhat.

Q. What extent of the land on each side of the conduit is drained by it? — *A.* I could not say.

Q. I don't mean by measurement; but to what considerable extent? — *A.* I should judge it drained it to a considerable extent.

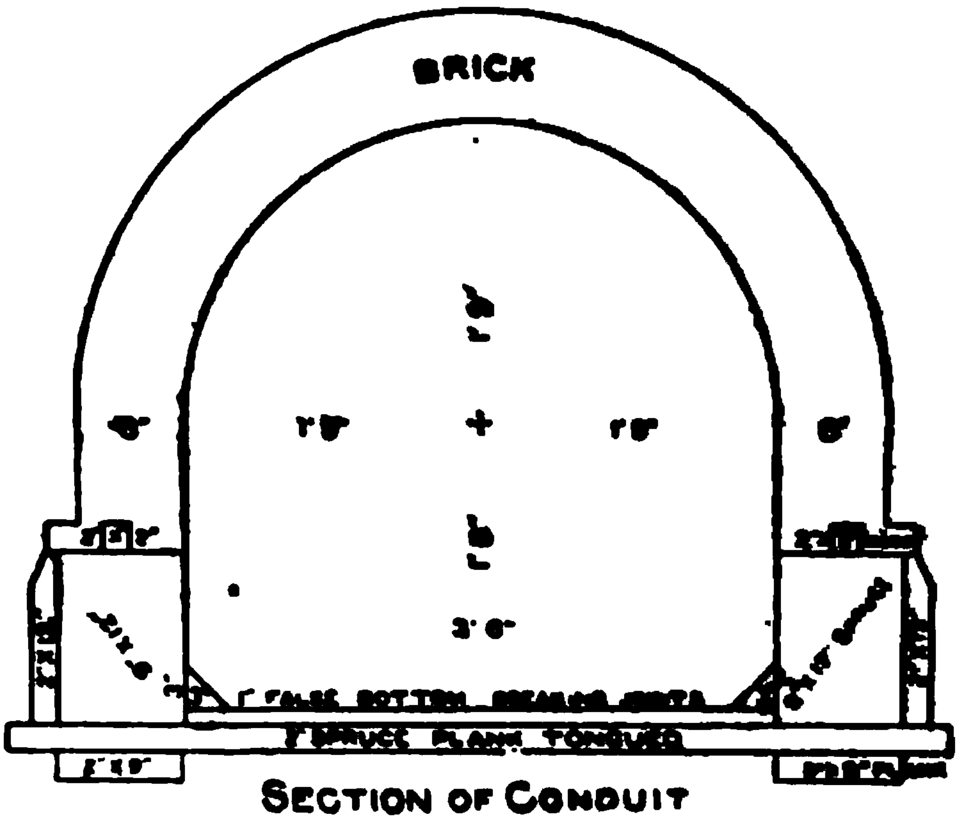
Q. Do you know whether there has been any effect produced upon the soil in the neighborhood of that conduit; whether it has dried up any? — *A.* I do not know.

[1] Between the pond and C. [2] Near Wellington Brook.

Q. The same form of construction used for a sewer, and put alongside Alewife Brook to deep water, would have some effect in draining the soil; would it not? — *A.* That depends upon the character of the soil.

Question by Mr. Hammond.

Q. You refuse to agree that this conduit was water-tight? — *A.* I never specified to build it so: the specifications called for an "aim," and I "aimed," and the "gun wasn't worth a cent." [The accompanying sketch of the conduit was shown; the arch is of brick, the rest wooden.]



Section of Conduit

Questions by the Board.

Q. The water wasn't over five feet from the surface through the gravel bed? — *A.* No, sir; I should judge not.

Q. You were not familiar with the former contour, &c., of the hills around there? — *A.* No, sir; not particularly.

Question by Mr. Hammond.

Q. Where were you pumping, when you drained the wells on the other side of Little Pond; I mean, how far off? — *A.* About half a mile: I put two pumps in the receiving-basin near Little Pond, and pumped over into the pond; and I kept running those two pumps at their utmost capacity. I found I was lowering the water on this side of the pond [beyond Cross Street], and at the same time was filling up Little Pond.

Question by the Board.

Q. How wide is the space between the ponds [Little and Spy Ponds]? — *A.* About 150 or 175 yards.

Thomas Carroll. — *Direct Examination by* Mr. Hammond.

Q. Are you the man that Mr. Poland had to superintend the conduit here? — *A.* Yes, sir.

Q. There is Fresh Pond [referring to map], and there is Concord Avenue; and here is the line of the conduit, along here; and there is

Little Pond, there: now, what is the character of the soil from Fresh Pond to about here [B]? — *A*. Loose gravel and a little sand.

Q. Where was the point of sand? — *A*. On Heywood's side.[1]

Q. That was fine sand? — *A*. Yes, sir.

Q. Did you have a good deal of water here? — *A*. Yes, sir: we could not take care of half of it. Sometimes we had a foot of water run down into the pond; you could not make it dry.

Q. How many pumps did you have there? — *A*. Two.

Q. Can you remember how long a section you tried at once? — *A*. Not more than twenty-five or forty feet.

Q. Do you mean to say that you put two pumps into that conduit, and could not pump it out? — *A*. Yes, sir.

Cross-examination by MR. WARREN.

Q. Did you see the water in the conduit? — *A*. I did, sir.

Q. Was it clear, or dirty? — *A*. Clear.

Q. Always? — *A*. Yes, sir.

WILLIAM S. BARBOUR. — *Direct Examination by* MR. HAMMOND.

Q. You are the city engineer of Cambridge, and have been since what time? — *A*. Since 1876.

Q. Was that plan made by you? — *A*. Yes, sir; under my direction.

Q. Will you point out on the plan the line of that Heywood gravel bank? — *A*. [Witness points out the line: *hh*, nearly.]

Q. What is the character of the soil near the slaughter-house? — *A*. Swampy; that is, near the corner.

Q. That is nearly level with the Concord-avenue turnpike, is it not? — *A*. Yes, sir.

Q. Does that come up around in that way so? [referring to map.] — *A*. Yes, sir.

Questions by the BOARD.

Q. Are all these swamps connected together? — *A*. I think they are; one way and another they are all connected.

Q. They all discharge into Alewife Brook? — *A*. Yes, sir.

Q. You have marked out there the line of swamp as it was before they commenced to put up the slaughter-house? — *A*. Yes, sir.

Questions by MR. HAMMOND *resumed.*

Q. What is the character of the soil there, out to the conduit there? — *A*. It is gravel and sand across to the pond.

Q. Is that conduit water-tight? — *A*. No, sir.

Q. How much beneath the surface of the ground is the top of the conduit? — *A*. From four to eight feet.

[1] Marked by the line *hh*, which also very nearly shows the limit of excavation, by a nearly perpendicular bank about thirty feet high. The point B is just about the natural level, and the rise is quite abrupt to the level of the muck-heaps, to which a foot-path leads. The slaughter-house is placed where the gravel-hill had been removed for filling the Miller's River district with gravel.

Q. How is it here? [referring to map.] — *A.* Here, near Concord Avenue, the depth is twelve feet to the bottom of the conduit.

Q. How is it here? — *A.* About seven and a half feet [where the new soup-pipe crosses]; it falls from Concord Avenue, but at this point [by the slaughter-house] the ground is higher, — perhaps eight feet from the top.

Q. Is that conduit tight? — *A.* No, sir, it is not tight.

Q. Have you made any experiment about that matter? — *A.* I have, sir.

Q. Will you state when the first experiment was made? — *A.* I think it was in July, 1876.

Q. What was that experiment? — *A.* I took some levels to determine the difference between the elevation of the water in the gravel pit and the water in the pond.

Q. I am speaking now of the conduit, sir. — *A.* I think, at the same time, I made a gauging of the flow of water in the conduit.

Q. Where? — *A.* Between that manhole [second from Fresh Pond] and the pond [referring to map].

Q. When did you first make an experiment to ascertain whether the water from the outside of the conduit got into the conduit? — *A.* At that time that was the first one.

Q. Your first experiment was to ascertain what water came from the whole length of the conduit? — *A.* No, sir; I had this gate closed [a gate near Wellington Brook, referred to on map], — there is a gate at this point across the conduit, — and with the gate of Fresh Pond open, I measured the flow between these two points.

Q. You closed the gate at Wellington Brook, so that there was nothing that could run out of the conduit, except what got into it between Wellington Brook and the pond: now, how much run out of that? — *A.* 1,071,924 gallons, or at that rate for twenty-four hours.

Q. Now, when was the next experiment? — *A.* The next experiment that I noticed was Nov. 19 of the present year.

Q. What was that? — *A.* This was immediately after a heavy rain, and I took the whole length of the conduit from Little Pond. The gate at the brook was opened, and that one closed [the gate near Little Pond].

Q. No communication with Little Pond? — *A.* No, sir; closed at the Little Pond end.

Q. Well, what was the flow? — *A.* 1,829,952 gallons, or at that rate for twenty-four hours. Nov. 16, the flow was measured under the same conditions of conduit, and the result was 995,036 gallons for twenty-four hours.

Q. What was the next experiment? — *A.* Dec. 6, 1878: I took this end of the conduit this time, and measured between that manhole near Wellington Brook, and that one near Little Pond, — this gate, near Little Pond, still closed, — and the result was 588,586 gallons, or at that rate, for twenty-four hours.

Questions by the BOARD.

Q. How did you measure? — *A.* By the flow.

Q. What is the whole fall of the conduit? — *A.* The whole fall between the gates is three (3) inches.

Q. How long is the conduit? — *A.* About four thousand feet long.

MR. HAMMOND *resumes Questions.*

Q. What is the size of the collecting-basin? — *A.* About forty-five by fifty feet, and covered.

Q. How far from Little Pond? — *A.* The edge nearest Little Pond is thirty feet from the pond. By measuring the current between the collecting basin and the first manhole, south, we get the velocity of current; and, by measuring between this point [the first manhole from Fresh Pond] and south, I get the other velocity.

Question by the BOARD.

Q. Did you make any allowance for the friction? — *A.* Well, I have observed the flow or velocity at all points, and I have not been able to detect any difference between the surface velocity and the centre velocity. I think both are about the same. I consider that I got the mean velocity, because I have never been able to detect any difference.

Questions by MR. HAMMOND, *resumed.*

Q. Now, at the time you gauged here, you gauged at the lower end? — *A.* I did.

Q. What was the result? — *A.* The result of gauging at the Fresh Pond end, between the first manhole and the pond, was 1,226,420 gallons for twenty-four hours' flow.

Q. Making about 603,000 gallons picked up between this point [Wellington Brook] and that [Fresh Pond, referring to map] by your experiment? — *A.* Almost that; yes, sir.

Q. When is your next experiment? — *A.* Dec. 16.

Q. Did you experiment at both ends in the same way? — *A.* I did.

Q. What was the result? — *A.* At the Little Pond end, I got a flow of 520,148 gallons.

Q. At the other end? — *A.* 1,113,294 gallons for twenty-four hours.

Q. That makes in the neighborhood of 600,000 gallons that it picked up between the two points? — *A.* Yes, sir.

Q. Did you make any other experiments? — *A.* On Dec. 18, I made another one.

Q. Same way? — *A.* No, sir; not exactly.

Q. What did you do on the 18th? — *A.* After the experiment of the 16th, I had that gate near Wellington Brook closed.

Q. Where did you take gauging? — *A.* Between the first manhole, north, and Fresh Pond itself.

Q. What was the flow? — *A.* Flow on the 18th was 846,377 for twenty-four hours.

Q. That gives the flow into the pond from that part of the conduit between Wellington Brook and the pond? — *A.* Yes, sir.

Q. Have you made any other experiment? — *A.* On the 19th, I made another, under identically the same conditions.

Q. What was the result? — *A.* 858,924 gallons.

Q. That shows what got into the conduit, between Wellington Brook and the pond? — *A.* Yes, sir.

Q. Did you make another experiment of that nature? — *A.* I have

another, but the notes are not yet completed. That was made, measuring at both ends.

Q. I understand you that this last experiment was made when the gate at Wellington Brook was closed on the 16th, and the experiment not made until the 18th? — *A.* Yes, sir.

Q. Now, Mr. Barbour, from your experiments, do you draw any conclusions about the water's running through? — *A.* I draw the conclusion that there is a large quantity of water discharged from the conduit into the pond. I think the most of it comes from where the hill has been cut into. This conduit skirts the lines of hills; and my impression is, that the water comes from the excavations, where the conduit passes through the gravel beds [B to Fresh Pond], and doesn't come in great quantities from the meadows.

Q. Would you expect from the fact of the conduit running along here [referring on the map to the vicinity of slaughter-house complained of] that this part contributed its full share? — *A.* I do; yes, sir.

Q. Have you made any experiments to ascertain whether the underground water here in this vicinity tends towards the pond, or not? — *A.* I have.

Q. Will you state when you began those experiments? — *A.* In October last. I had some pipe-wells sunk in the bank.

Q. How many? — *A.* Five.

Q. Where were they located? — *A.* They commenced on the westerly side of the Heywood gravel bank, and passing along in the direction of the slaughter-house; they are numbered 1, 2, 3, 4, and 5. No. 5 is on the premises of the slaughtering-establishment.

Q. How large pipes? — *A.* Part of them two-inch, and part of them four-inch iron pipes.

Q. Holes dug, and pipes inserted? — *A.* Yes, sir.

Q. When did you begin that operation? — *A.* I think, Oct. 14.

Q. Have you plans showing it? — *A.* I have some diagrams.

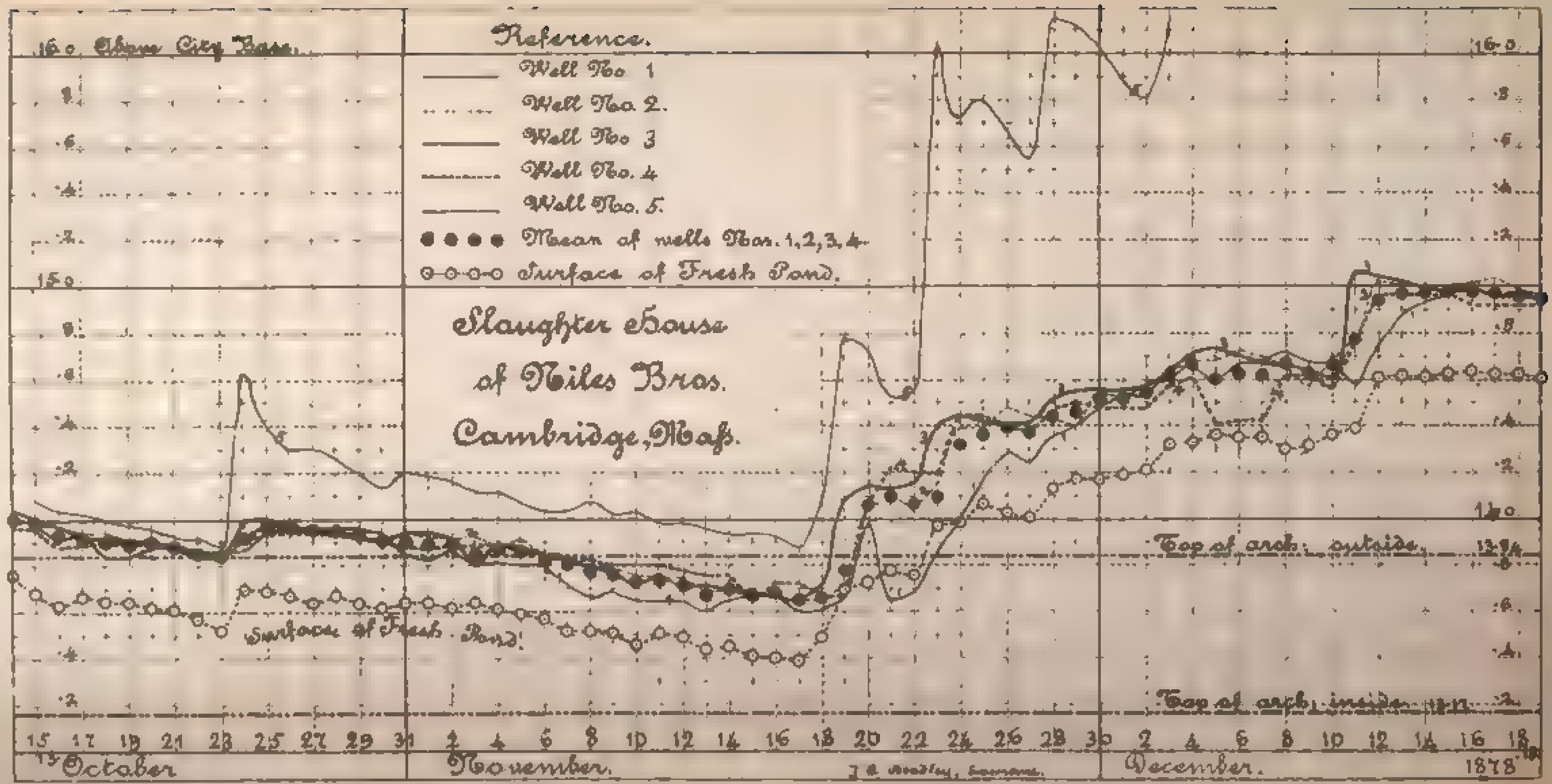
Q. Will you state whether you find the water higher or lower here than in Fresh Pond? — *A.* I have found the water in this gravel bank to stand a little higher than the water in the pond, keeping very nearly the same relative difference, — between from one and a half to three and four inches.

Q. What period of time have your experiments covered? — *A.* Continuously from the first one, dated Oct. 14, to the last one, Dec. 19, 1878.

Questions by MR. WARREN.

Q. How were the pipe-wells constructed? — *A.* I dug a hole as deep as I could without being troubled with water, and then, in some cases, drove the pipes down, and then scooped the material out from the inside with a scoop.

Q. How low down was the bottom of the pipe when you got through? — *A.* Sufficiently far, so that the float that I used has grounded only once in well No. 1. I intended to have the pipes deep enough to cover all the fluctuation, and think, with the exception of pipe No. 1, they have been in that condition. No. 1 is the first one on the westerly side of Heywood's bank.



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Question by Mr. Hammond.

Q. How low down did you have to go to get water? — *A.* You can get water now in less than three feet.

Questions by the Board.

Q. What is the general level? — *A.* It varies. In the lowest part, the water is got in three feet. In the lowest holes, water is exposed now.

Q. How would that be about the engine-house [E]? — *A.* Very nearly the same level; water a little higher, — surface of ground perhaps six or eight inches, possibly a foot higher.

Question by Mr. Hammond.

Q. Please explain to the Board your diagrams. — *A.* [Witness takes one diagram, and says] That shows the level of the pond in each case. There is the top of the conduit, and this line represents the surface of the water in the gravel bank, as determined by measurements taken at five different places, they being numbered 1, 2, 3, 4, and 5, and corresponding to these points shown here, 1, 2, 3, 4, and 5. From the time these experiments were first made, or commenced, until the closing of them on Dec. 19, you will find the water in the pond has risen nearly a foot, yet you will find the relative height very nearly the same.

[This is shown graphically by the chart on the opposite page, as arranged and drawn by Mr. Hoadley, of the Board. At the hearing, the observations were shown for each few days, on separate sheets.]

Question by the Board.

Q. What is the square? — *A.* One of these large squares represents two-tenths of a foot; one of the small squares [not shown] represents four-hundredths of a foot. The surface of the ground is not shown.

Questions by Mr. Hammond.

Q. From these various experiments, what conclusion did you come to about the water under that bank going into the pond? — *A.* I think it finds its way into the pond.

Q. Think it circulates freely around? — *A.* I think it moves very freely indeed.

Q. Now, sir, in your own mind, how do you account for the sudden rise in No. 5? — *Q.* I can only account for it in my own mind. I have a "theory" in the matter.

Q. Have you confirmed it by experiments? — *A.* I have.

Q. If there is no objection, and the Board care to hear them, you can give them. — *A.* In the case of No. 5 — [Interrupted.]

Question by the Board.

Q. What is the difference between these points in feet? — *A.* The difference is shown here between the level of the pond and the level of the water in pipe No. 4. On the 14th of October it is .19 of a foot; it runs along .27, .28, .23, .25, and .26, and so along up to .33 and down to

.25, and runs along about in that ratio, .19, .20, .25, .30, .33. That is the difference in the level of the water in pipe No. 4 and the pond; in the mean time the pond has risen about a foot.

MR. HAMMOND *resumes.*

Q. Now will you explain to the Board the rise in No. 5? *A.* The first rise in the water level was after a heavy rain of Oct. 24.

Q. When does that sheet begin? — *A.* That begins Nov. 27.

Q. When does it end? — *Q.* Dec. 2.

Q. Now, on that sheet you find a great difference between the relative rise of No. 5 and the rest of the pipe-wells? — *A.* I do.

Q. How do you explain the difference between No. 5 and No. 4 on that plan? — *A.* One foot and .16 on Nov. 27 was the difference between No. 4 and No. 5.

Q. Was that about the average right along that week? — *A.* No, sir: some days more, and some less.

Q. Now you may go on, and state your view of that fact. — *A.* At this point, in the rear of the piggery [P], there has been an excavation made: [they have taken out muck or mud, and carted it to the top of the hill] and in most cases this was to hard bottom; and it occurred to me, that in making their excavations there they had cut into the gravel bank or stratum, and when this filled up with water it passed through more freely than it did before, and affected No. 5.

Questions by MR. WARREN.

Q. Did you make any comparison of the level of the water in this excavation and well No. 5? — *A.* I could not: when I discovered this, I hadn't the use of the No. 5. I could not make any comparison with No. 5 and the water here. No. 5 had been covered up; and I couldn't use it.

Q. Between Nov. 22 and Dec. 2 you took those levels on that profile: at that time, did you take the levels of the water in that pond? [behind the pig-house.] — *A.* I have taken it twice.

Question by MR. HAMMOND.

Q. Did you then? — *A.* No, sir.

Question by the BOARD.

Q. Is there any one date that you have taken it when this was taken here? [No. 5, referring to map.] — *A.* I don't seem to find it.

MR. HAMMOND *resumes.*

Q. Very well, we will pass on to another part of the case. How long ago should you think that slaughtering was begun in this place? *A.* Four or five weeks ago.

Q. Will you state where their drain-pipe is? — *A.* It is represented by the line [from P to K]. It is a three-inch iron pipe, and laid under ground about three feet; and about twenty-five hundred feet long.

Q. When was that pipe laid, as near as you can give? — *A.* Laid just before they commenced to operate, about five weeks ago.

Q. Have you observed that pipe since? — *A.* I have been over the line several times.

Q. What have you observed? — *A.* At two different times I have found it leaking.

Q. Can you give or state in how many places? — *A.* Five places.

Q. Can you locate on the map where? — *A.* Not exactly.

Q. Well, give us as near as you can. — *A.* There is one leak at that point near the boundary-line, and four others between that leak and Alewife Brook. Down here in the swampy ground, it follows the railroad-track (Fitchburg), being laid on the embankment between the two tracks.

Q. How did you observe these leaks? — *A.* I saw it on the surface of the railroad.

Q. What did you see? — *A.* What looked like blood: it was reddish in color, and thick as "soup."

Q. Any smell? — *A.* Yes, sir.

Q. What? offensive? — *A.* Yes, sir.

Q. Largely so? — *A.* I noticed it as I passed along.

Q. What quantity? can you give any idea? — *A.* Quite large: a patch as long as this table [ten feet], perhaps.

Q. What color? — *A.* Reddish.

Q. You observed that more than once? — *A.* Twice.

Q. The second time were the leaks in the same places, or elsewhere? — *A.* I think very nearly in the same places, and looked about the same as the first.

Q. How long ago? — *A.* It was within a fortnight.

Q The first time about two weeks ago? — *A.* Yes, sir; and the difference in observation about two days.

Q. Have you observed any repairs on that drain? — *A.* They were making excavations at the time, with a view to making repairs, I judged.

Q. How many men were there? — *A.* About half a dozen men, I should think.

Q. Mr. Boynton there? — *A.* I don't remember seeing him.

Q. What were they doing? — *A.* Excavating.

Q. Did you see them excavating? — *A.* I did in one place.

Q. Where was that? — *A.* It was about midway.

Q. Did they repair the pipe? — *A.* I do not know, sir.

Q. How far did they dig down? — *A.* I should think, about two feet.

Q. Did you see the stuff as they went? — *A.* Yes, sir.

Q. How did it look? — *A.* It had a reddish appearance, as though it was contaminated with the flow of the pipe, and had an offensive smell.

Q. Largely so? — *A.* I thought it was a pretty bad smell. I noticed it in walking about. I couldn't smell it a great ways off.

Q. Was it stated to you by any one there, any thing about the pipe being stopped up?

MR. WARREN. "Stated?"

Mr. Hammond. — *Q*. Did you see any thing of the "stuff" that stopped the pipe? — *A*. I supposed it was stopped up.

Q. Anybody say any thing to you about it? — *A*. I don't recollect about that fact [of its being stopped up]. I was informed the pipe was leaking.

Q. And you went the whole length of the pipe for the purpose of ascertaining? — *A*. Yes, sir.

Q. Have you observed that pipe at any other time? — *A*. I have been over it several times.

Q. Since? — *A*. Yes, sir.

Q. Any leak since? — *A*. Not since they laid the pipe anew.

Q. Was that an iron pipe? — *A*. Yes, sir.

Q. Flange? — *A*. Bell and spigot joints.

Question by the Chairman of the Board.

Q. Is there a leak now? — *A*. I have not noticed within a few days.

Mr. Hammond *resumes*.

Q. That is not below the frost, is it? — *A*. I think about three feet deep on the railroad-embankment.

Q. Is the railroad dug out, or banked up? — *A*. Banked up, and about twenty feet wide.

Q. Then you have no further observations on that? — *A*. No, sir.

Q. Where does that "soup" pipe run from? — *A*. From a point here [referring to map], it passes along that line near the conduit, and up on the hill [*a* B S].

Q. You mean, it did run there? — *A*. Yes, sir.

Q. Underground? — *A*. Yes, sir.

Q. How far? — *A*. Three feet.

Q. Where it crossed the conduit, how far from the top of the conduit would it be? — *A*. About one foot.

Q. How far is that hill, upon which the soup is deposited [muck-heap], from the conduit? — *A*. By the pipe, as it was originally laid, it was something over eight hundred feet from the slaughter-house.

Q. I mean, from the nearest point of the conduit? — *A*. It did cross the conduit in part, and run right alongside of it, within thirty feet, crossing it at quite an acute angle.

Q. How far is the hill of final deposit? — *A*. About nine hundred feet from the slaughter-house.

Q. How far are the muck-beds from the nearest point of the conduit? — *A*. I couldn't say exactly. On the opposite slope of the hill, I should say it was three hundred feet.

Q. And that is a gravel hill, isn't it? [referring to map] — *A*. The appearance shows it is.

Q. And our conduit runs right along at the foot of that hill? — *A*. Yes, sir.

Q. And there is no swamp between the conduit and the muck-bed? — *A*. No, sir. The swamp comes near to it at one point.

Q. How large is the muck-bed? — *A*. I couldn't say.

Q. Some idea — whether there are a hundred acres? — *A.* I shouldn't think the muck-beds would cover one-half an acre altogether.[1]

Q. Now, have you made observations along the line of that three-inch flange iron pipe? — *A.* Yes, sir.

Q. State what you saw the first time you saw any thing objectionable there, and when it was. — *A.* They commenced to use the soup-pipe Wednesday night. I went upon the hill, to the muck-beds, and found that the pipe had been used some time between eight and nine o'clock in the morning, and three and four o'clock in the afternoon before, — the precise time I don't know, — and saw the material which had been pumped up. I then followed down the line of the pipe to the point [B] where the angle is; at a point a few feet from it, this side of the angle, I noticed a discoloration of the water lying on the ground. I took my umbrella, and stirred it up, smelt of it, and made up my mind that it had been leaking. At that point the water was of a reddish color, and there was a decided smell to it.

Q. What did you do? — *A.* The superintendent of the water-works was with me, and noticed the same thing; and I said to him that I thought he ought to get a sample of that. The result was, we got a bottle, and brought it down, a fair sample of it, as it was there.

Q. Can you give the Board any idea of the quantity there was, and the space of the ground it covered? — *A.* I should say it covered a place one-half as large as the map [about six feet square].

Q. State the effects of it. — *A.* There was water laying in the ruts [cart-ruts], so that he put a bottle down, and took it up full.

By Mr. Warren.

Q. Well, that does not express any definite way: you might have taken a spoon, and filled the bottle. — *A.* We had no difficulty in getting it. He put the bottle down, and let the water run into the mouth.

By Mr. Hammond.

Q. How large a bottle? — *A.* The bottle might have held a pint.

Q. Was there any thing else on the line of the pipe that you saw objectionable? — *A.* I don't recollect noticing any other leaks at that time.

Q. That was the day after it began to be used? — *A.* I never knew of its being used before.

Q. Did you notice it any other time? — *A.* I think not.

Q. Now, where the ground is frozen, can that soup, after it gets up there, soak into the ground? — *A.* I should think it would be difficult to soak it when it was frozen.

Q. Will you state where, if any thing soaked through there, or if it run off, what direction it would go from that hill? — *A.* The direction of that slope is toward Wellington Brook.

[1] The beds are of loam and of muck, about three feet deep, and covering nearly three-quarters of an acre. The amount of soup disposed of on them has been estimated not to exceed a daily average of two thousand gallons; so that any one part of the heaps need not be treated with the "soup" oftener than about once a month.

Q. That is one of the streams from which we get our water-supply? — *A.* Yes, sir.

Q. How far is it from Wellington Brook? — *A.* I think, about twelve hundred or fifteen hundred feet.

Q. You consider it a part of the water-shed running into the brook? — *A.* Yes, sir.

Q. Now, have you noticed any cars standing over on that track, near the two buildings? — *A.* I have.

Q. State what you observed, if objectionable or otherwise? — *A.* One time when I was up there it had been raining; I noticed the drippings from the cars on the ground.

Q. When was that? — *A.* One Tuesday, about three weeks ago, I saw the drippings from the cars.

Q. How many? — *A.* Quite a number.

Q. They were open hog-cars? — *A.* Slatted sides.

Q. Was there any dung from the hogs on the bottom of the cars? — *A.* Yes, sir.

Q. Manure? — *A.* Yes, sir.

Q. They were dripping? — *A.* Yes, sir.

Q. In the rain? — *A.* Yes, sir.

Q. Did you observe any smell about the premises? — *A.* I have, at times.

Q. Any thing offensive? — *A.* Yes, sir; such a smell as you would get from hogs, &c.

Q. Live or dead hogs? — *A.* Both.

Q. How is the muck-heap? does that smell? — *A.* The time I was over, they had not put enough into it to amount to very much.

Q. You have stated that the superintendent was with you at the time you observed that fluid from which he took the sample in the bottle· was he with you when you passed up and down that train there? — *A.* He was.

Q. Anybody else? — *A.* No, sir: I think not. I don't recollect anybody else.

Cross-examination by MR. WARREN.

Q. You say the muck-heap didn't smell much: did it smell at all? — *A.* Yes, sir.

Q. What kind of a smell? — *A.* I can't describe it. It was the same smell I smelled on the railroad-track.

Q. Well, that up on the muck-heap was the soup, wasn't it? — *A.* I judged it was.

Q. You don't suppose that was soup down by the railroad-track? Couldn't you distinguish any difference in the smell? — *A.* I don't think I could.

Q. The amount of these drippings which came from these cars, which were used to carry swine, — how many acres of land would that supply with manure? — *A.* Well, not a great many.

Q. Is it within reasonable bounds to say that there are ten thousand times as much hog-manure put on that surface, as you saw there? — *A.* Well, that would depend upon the business they do, and the number of cars they bring there.

Q. I mean the amount you saw in the midst of that storm: a greater portion of that territory about the pond is used for market-gardens, and heavily manured, is it not? — *A.* Yes, sir.

Q. With manure from cow-yards, horse-barns, &c.? — *A.* I suppose so.

Q. Now, I understand you that the pond receives from this conduit between one and two million gallons of water every day, — simply what comes by drainage through the sides? — *A.* Yes, from that and the collecting basin.

Q Does the water get into the basin from the pond [Little Pond]? — *A.* To some extent.

Q. Is that, then, the whole amount of water that runs through to the pond? — *A.* Yes, sir. The larger amount is the final discharge.

Q. When the conduit is connected at the other end, you don't draw directly from Little Pond? — *A.* No, sir.

Q. And you don't take any water from Wellington Brook? — *A.* We have at times, but not this season.

Q. Is the conduit in use now? — *A.* In the way in which I have described. The gate [into Fresh Pond] at Black's Nook is open.

Q. Open all the way, isn't it? — *A.* No gate is open leading into it from Little Pond or from Wellington Brook. We have a gate across the conduit to divide it into two parts, so by opening or closing that I got experiments on the two ends of the conduit. We have also another gate by which the water is taken directly from Wellington Brook if desired.

Q. What use is being made of the conduit now? — *A.* To take the water from the leakage in the conduit.

Q. That was the case when you made these experiments of Dec. 16 and 18? — *A.* That includes the collecting basin.

Q. From what you observed at this point of the leakage of the soup-pipe, how many gallons of water, or pints if you please, should you say had escaped at that leakage? could you form any idea? — *A.* I don't know that I could. It must have been in the ground, and it came up from the pipe on to the surface, and showed itself on the surface. I don't know as I could say how many "pints" or quarts or barrels; but it leaked enough to come up through the covering to the surface.

Q. As a matter of fact isn't there a spring at the side of the hill from which the water had been running, and stopped in these cart-ruts? — *A.* There was other water there in the ruts.

Q. Since that time, that pipe has been taken up, and replaced by a pipe laid above ground? — *A.* Yes, sir.

Q. Were you present when the pipe was laid under ground? — *A.* No, sir.

Q. And I take it you made no suggestions to anybody of any danger from the plan? — *A.* I spoke of it with persons connected with the Water Board as very objectionable.

Q. Then you were aware that it was objectionable, and might not be satisfactory. You did not make any suggestion to Mr. Boynton? — *A.* No, sir: I had some talk with Mr. Boynton after it was laid, and told him that I thought it would leak, from the nature of the flange-joints, and that a less rigid pipe would be better.

Q. Can you give us any approximate idea or estimate of how much water could escape through a leakage at one of those joints in twenty-four hours? — *A.* I am not prepared to make any such statement now.

Q. I suppose it would depend on what amount of force was used, partly? — *A.* Yes, sir.

Q. To press or drive the water through the pipe? — *A.* Yes, sir.

Q. For the first three weeks after they had begun operations you saw no signs of any leakage in the drain-pipe, did you? — *A.* Well, I haven't tried to give any dates about that. [Interrupted by Mr. Warren.]

Q. I don't care for the exact dates. Have you got notes to show them? — *A.* I think I have.

Q. I should like to see them: if I can find out those dates, I can fix to some extent what the weather was. — *A.* The leakage in the flange-pipe [soup-pipe], I have noted the 12th of December; under date of Dec. 6, I have notes referring to leakage in the drain-pipe.

Q. Your second observation was on the 8th of December? — *A.* I think it was the 7th or 8th: I don't seem to have noted it.

Q. Before that time there had been no leakage that had been perceptible to you? — *A.* I think that was the first time I saw it.

Q. As a matter of fact hasn't the water been unusually high in Alewife Brook? — *A.* No more than usual during such rains as we have had.

Q. Have we ever had such rains during your recollection? — *A.* Not at this time of the year.

Q. The people carrying on the business saw the leak first, or did you? — *A.* I think the first time I saw it, there were men there employed in making excavations for repairs.

Q. The repairs were put through with all due expedition, were they not? — *A.* Yes, sir.

Q. And since the pipe has been relaid there has been no trouble? — *A.* No, sir.

Q. Those two observations of leakages are all that you have; and both of those the Niles Brothers have remedied immediately, have they? — *A.* Yes, sir: I think they have.

Q. I want to ask you as a civil engineer, would you consider it quite fair to treat an enterprise as a failure, because some slight accident might happen to the machinery when they first undertake to establish it? — *A.* I don't know as I should be prepared to go so far as to say that I should.

Q. You have observed nothing else except what you have stated, that has been objectionable to you? — *A.* That is all that occurs to me now.

Q. Now, you speak of the smell of dead hogs and of live swine: can you distinguish the smell outside of the building in which they are kept? or, rather, could you? — *A.* I thought I did.

Q. You had to go pretty close to the building? — *A.* Pretty near it.

Q. Couldn't smell it to the street? — *A.* No, sir.

Q. Has there been any time when you could smell there any smell whatever? — *A.* I think so.

Q. When was that? — *A.* I recollect one time I noticed the smell from the building.

Q. Can't you give us the time? — *A.* I don't think I can give you the date.

Q. Now, how long did that smell continue? — *A.* I think I have only noticed it once or twice.

Q. Don't you know that in their first experiment of using the "drier," there was some defect on the part of the putting together, which made it work imperfectly in one or two trials? — *A.* I don't know any thing about it.

Q. You say you can't fix the time when you observed any smell in the streets; have you observed any smell in the street within ten days? — *A.* I think I noticed the smell at the time I went up the railroad, up through here [pointing to map].

Q. That was about the 6th of December? — *A.* Yes, sir. The wind was blowing from the west. I was quite certain I smelled it at the brook, before I reached the railroad.

Q. That, you think, was about Dec. 6? — *A.* I think so: about that time.

Q. What is the height of the water in this artificial ice-pond? — *A.* I haven't any thing to show it.

Q. Have you ever taken the level there? — *A.* No, sir. I have the height of the water taken at this point in Alewife Brook: there is not much difference.

Q. You may give that. — *A.* I have that from Dec. 13 to 19.

Q. In the first place, you say that there is not much difference: how confident are you of that? — *A.* I think the water is nearly the same over these meadows, and that there is a connection through here [near Concord Avenue] somewhere; and there is a ditch goes right up here somewhere [pointing to map], so it may be the same level.

Q. I don't care about it, if you cannot give me the relative height. You have had a good deal to do with the sewerage of this district, haven't you? — *A.* I have made some examination with reference to the sewerage of this district, and the shores of the pond.

Q. Now, is there any satisfactory way to drain this flat district in the neighborhood of the Alewife Brook, except by building a sewer by the city of Cambridge to deep water? — *A.* That is a plan I have already communicated to the Water Board, about a year ago.

Question by the BOARD.

Q. To Charles River, or the Mystic? — *A.* Both: either of them.

MR. WARREN *resumes.*

Q. There are some reasons favoring one, and some the other? — *A.* Yes, sir.

Q. If you took your sewer over to Charles River, would it drain as much of this swampy land as if you took it the other way? — *A.* The natural drainage is with the brook, but I think it could be taken the other way. The objection to taking it that way is the greater expense.

Q. I suppose it would afford more accommodations to residents in Cambridge? — *A.* Yes, sir; but the natural drainage is in the other direction.

Q. You have stated, when you were directing your experiments to the quantity of water which went through the conduit, there was always something floating through: what is there that is floating through this conduit? — *A.* What I referred to was a vegetable growth.

Q. Growing in the conduit itself? — *A.* I have never been able to satisfy myself where it came from.

Q. What is its appearance? — *A.* Yellow vegetation, — nearly the color of that blotter.

Q. Is it detached matter? — *A.* It is in minute particles, usually; and, in some cases, in clots of from three to four inches across.

Q. Is it all vegetable? — *A.* I took it to be.

Q. Does it seem to occur in the pond itself? — *A.* I never saw it in the pond. We have another growth which has been discovered in the pond, — a greenish growth; but I have never seen this yellow growth in Fresh Pond, except what comes through from the conduit.

Q. Does that make much impression in the water of the pond, — much show? — *A.* At one time it did make some show there.

Q. Does it give to the water any effect? — *A.* I think it did at the time.

Q. I observe, at a hearing in City Hall a while ago, that it was stated (and I find it here in your water reports), it was stated that the water-supply was estimated as three million gallons per inch, and that afterwards, in the next year, at five million gallons per inch. Do you know any thing about what is the estimated supply? — *A.* I think it is called five millions now.

Q. Per superficial inch? — *A.* Per inch in depth.

Q. That is, take the whole area of the pond? — *A.* Yes; an inch deep.

Q. What extent of territory drains into the pond by surface drainage? — *A.* In the drainage of Fresh Pond?

Q. Yes, sir. — *A.* The drainage area of Fresh Pond has been called twelve hundred acres. I should not state it now at over eight hundred acres, as a large part of it has been cut off.

Q. What is the nature or character of the material carried into the pond with the water? — *A.* Such as is carried in. That which comes into the Fresh Pond is of much better character than in any other pond around. I don't know as I could describe that exactly to your satisfaction.

Q. Well, now if your experiments with these wells and in the conduit show any thing, they would show that there is all around this low territory from Little Pond to Fresh Pond, and to Spy Pond, a water level, not always at the same height, but a water level, so that the water between these ponds is connected; wouldn't it? — *A.* I should have my doubts about that.

Q. I don't mean connected by brooks, but connected so as to affect each other. — *A.* It is pretty well understood that Fresh Pond is largely supplied by underground deep springs.

Q. Is the land about Little Pond in a high state of cultivation, and is it heavily manured with night-soil? — *A.* It is.

Q. And Little Pond is in direct communication with Fresh Pond by the conduit? — *A*. It is; but we have never drawn the water through it, except so far as we do it through the collecting basin.

Q. Now, the west side of Spy Pond is highly cultivated? — *A*. Yes, sir.

Q. For gardens? — *A*. Yes, sir.

Q. Now, what is the Cushing-street district that I have heard spoken about in connection with this investigation? — *A*. It is a district on the south-west side of the pond; there is a small pond, or two, one upon the hill, and one down near the pond. Certain seasons of the year they discharge into Fresh Pond.

Q. I will ask if you have seen Dr. Cogswell's Report[1] on Fresh Pond. — *A*. I have.

Q. Now, from your own knowledge and experience, are the facts as stated in his report substantially correct? — *A*. I think so.

Q. Now, what measures has the city of Cambridge taken thus far to protect the waters of Fresh Pond from all of these actually existing impurities? — *A*. They have been trying for a long time to get something to alleviate this Cushing-street trouble, but have not yet succeeded in stopping it.

Q. Have any steps been taken to build a sewer or drain around the margin of the pond? — *A*. Yes, sir.

Q. How far have they proceeded with that? — *A*. The surveys have been made.

Q. No action has been taken by the City Council? — *A*. No, sir.

Q. Now, what is the present sewerage of this district on the Cambridge side? — *A*. There is a sewer at Concord Avenue, another at Spruce Street, and still another sewer at North Avenue farther down.

Q. The stream of the Alewife Brook is not a rapid one? — *A*. Not rapid.

Q. But it is a constant stream? — *A*. Yes, sir.

Q. Does the tide come up as far as Fresh Pond? — *A*. There are gates fixed there to prevent it.

Q. What territory is drained by those three sewers? how much in extent? — *A*. The North-avenue district, I think, is about a hundred and eighty-two acres; the Spruce-street sewer drains some three hundred and eighty-three; the Concord-avenue [almost exclusively surface-water], something over a hundred and ninety-eight acres.

Q. I suppose there is no question of this: that the water from the surface alongside of Alewife Brook is taken away by the brook, and not the water in the brook absorbed into the land on the side? — *A*. Usually the flow is down to the outlet; when there are heavy floods coming down in this direction, then there is danger of the water backing up, and overflowing the meadow. We have gates put there to stop it.

Q. There is a hill there? [pointing to map.] — *A*. Yes, sir.

Q. Now, assume for the purpose of argument, that the hill here, &c. when you get down here [between the point B and the piggery], doesn't

[1] From The Sanitary Condition of Cambridge, published in the Ninth Annual Report of the State Board of Health.

the water-drainage go towards Alewife Brook and not towards the pond — I mean the underground water? — *A*. I don't think I could answer that question.

Q. On this side where those muck-beds are, so far as the surface drainage goes, it would be in another direction: how soon would it strike the swampy land? — *A*. There is swampy land on the edge of Wellington Brook about eight hundred feet from where the muck-beds are.

Q. Is there any place where the clay comes to the surface between that point [the muck-heaps] and Wellington Brook? — *A*. I could not say. I don't know. I couldn't answer that question.

Q. If there were, I suppose that would afford a barrier against the water coming into the brook? — *A*. If there were; yes, sir.

Q. This is pretty high land here where the muck lies? — *A*. Yes, sir.

Q. In order for the water at this hill to get into the pond at all, it has got to take its course down that hill, and then through the hill to get into the pond, unless it goes into the pond around here; hasn't it? — *A*. Yes, sir.

Q. Now, you find the levels of the water higher at No. 5 than they were at No. 1? — *A*. Yes, sir.

Q. So that, if you can tell any thing from those, it would show that the water-slope is in that direction? — *A*. Yes, sir.

Q. Well, if it was flowing in that direction here, what course would it take to flow into the pond? — *A*. I couldn't say. My idea was, that, in cutting and digging out this meadow here, they cut into the gravel-bed, and that previous to that the deposits of the meadow had formed a lining which had prevented it from leaking through.

Q. If I understand the situation of things, if the conduit were not there, the natural flow of the water from the slaughter-house would be in that direction? [toward well No. 1.] — *A*. Yes, sir.

Q. That is, from the pond, and not to it? — *A*. I couldn't tell.

Q. I suppose you have no estimate of the amount of water or liquid of any kind carried through that? — *A*. I have not.

Q. Before you could answer as to the possible effect ultimately upon the brook, you would want to know the quantity and character of the material? — *A*. Yes, sir.

Questions by the BOARD.

Q. Is it possible to make the conduit so tight as to prevent any thing from getting into the pond? — *A*. I don't suppose the present conduit could be made tight. It is possible to have another style of construction, which might be made tight.

Q. Do you know whether the drain-pipe is submerged or not, at ordinary height of the water? — *A*. It is now. I cannot say whether it will be at all times, or not.

Q. There is a good deal of fall besides the three feet, isn't there? — *A*. I don't know.

Q. You know about this pipe [for the soup]; this pipe has been taken out of the ground, and laid overhead on the surface? — *A*. Yes, sir: it is now laid [c S] upon the top of "trestle-work" which is shown

on that plan [extending from the slaughter-house to about the line *hh*, where it enters the excavated edge of the hill, and about twenty feet above the surface of the ground (as now excavated)].

Q. Then there is no longer any danger from that pipe? — *A.* No, sir.

Q. Do you think the soup can be properly disposed of, so as not to contaminate Wellington Brook? — *A.* I think there would be danger from it.

Q. I suppose this pipe is now fixed so that they can drain it after using it? — *A.* Yes, sir.

Q. Do you know whether they have any method of taking care of it to prevent it from freezing? — *A.* I don't know.

Q. Is there clay under this gravel bed here? — *A.* There is a point [near B] here where clay has been noticed.

Q. You have noticed any here? — *A.* No, sir. In sinking well No. 1, I did not notice any thing but sand and gravel.

Q. How deep was the pipe sunk? — *A.* I should say, about nine feet.

Q. Much below the water level? — *A.* Yes, sir: it went perhaps two feet below the water level.

Q. And you didn't reach the clay? — *A.* I did not reach clay.

Q. So that that is an indication that there is no clay there at the water level? — *A.* I haven't discovered any.

MR. NEVONS *called.* — *Direct Examination by* MR. HAMMOND.

Q. Your name is Hiram? — *A.* Yes, sir.

Q. You are the superintendent of the water-works at Cambridge? — *A.* Yes, sir.

Q. And have been for how long? — *A.* About two years.

Q. Have you passed over the drain from the slaughter-house to Alewife Brook, since its construction, — since they have begun to slaughter? — *A.* Yes, sir.

Q. How many times? — *A.* I think every day, except Sundays, since the fifth day of December.

Q. Have you at any time observed any thing upon the line of that drain offensive? — *A.* Well, the first day I went over, was in company with the engineer, they had six leaks, I think.

Q. Can you locate them on the map? — *A.* Very near: I think the first one was within about eight hundred feet of the brook, and the others were scattered along clear up to what is known as Heywood's road [N] to Block Island.

Q. What did you observe then in those places? — *A.* I observed this "soup:" a sort of a sediment.

Q. In all of them? — *A.* Yes, sir.

Q. What was its color? — *A.* That day it looked sort of a muddy, yellow color.

Q. Was it offensive in smell? — *A.* It was.

Q. Was there anybody with you? — *A.* The city engineer.

Q. Was there any blood in it? — *A.* I think not the first day.

Q. Can you state what extent of ground it covered? — *A.* I should think the places they had dug out were from four to six, perhaps eight, feet long.

Q. Did you see where they had dug out? — *A*. Yes, sir.

Q. Did it seem to be in the ground? — *A*. Yes, sir.

Q. Some sort of offensive stuff? — *A*. Yes, sir.

Q. The men were there, were they, repairing the pipe? — *A*. I think the men had got through, except one near Block Island road.

Q. Was there any thing said to you about the cause of it? — *A*. No, sir: not that day.

Q. Well, when was the next time? — *A*. I think it was the eighth day of December.

Q. What was the difficulty then? — *A*. I was passing down the railroad-track; got down within, I should say, about nine hundred feet from the brook: they had a place dug out, and two men were bailing the stuff out as it passed out from the joint.

Q. That was on the 8th? — *A*. Yes, sir.

Q. They had a piece of the joint up? — *A*. No, sir: they were bailing out, and it was exposed to view; and while I was standing there, it was bloody, and they said it flowed back from Alewife Brook. I went down towards the brook, and saw Mr. Boynton; and he said their pipe was stopped up somehow, and wouldn't work. There were leaks after that, every day, I guess, until they uncovered it, and leaded the joints.

Q. When did they uncover it? — *A*. I made notes the same day, Saturday, Dec. 14. I saw about ten of the joints that were made up. The first time that they excavated, a man went along with oakum, and drove it in on top, and then a man cemented the oakum.

Q. How did they repair the joints? — *A*. I saw one. They took and laid a course of brick around, lapping the joint, and cemented the brick.

Q. Then how did they fix it? — *A*. Then they drove the gasket.

Q. Have you seen any thing objectionable since? — *A*. Yes, sir.

Q. Well, when? — *A*. I think it was the 15th of December.

Q. What did you see? — *A*. I was passing down the track, and I saw where they had a "T." When they re-laid that portion of the pipe, they had a "T" put in, so that if the pipe was stopped up they could see what was the matter. They turned the "T" up. When they left it they covered it over with brick, so Mr. Boynton told me. They went to pumping, and blew the brick and cement off, and the drainage came up through the ground. When I saw it, there were two men bailing it out each way. This was a bloody substance, very thick, and very offensive to the smell.

Q. Did you see any thing else? — *A*. Not on this drain, excepting, I think, the next afternoon. We had been watching at the end of the drain to see if there was any thing floating. We saw that this bloody substance showed itself in Alewife Brook[1] for about forty feet.

Q. Water discolored? — *A*. Very offensive.

Q. Redness go down about forty feet? — *A*. Yes, sir.

Q. How wide? — *A*. From three to four feet.

Q. That is, from the drain, was it not? — *A*. Yes, sir.

[1] This is about a yard and a half wide and a foot deep at full water, at the outlet of the drain [K]. The current is never rapid, and nearly or quite absent for a certain time twice each day, when the tide-gates, a mile and a half below, are closed.

Q. Now we pass to the other pipe which runs to the muck-heap? — *A.* Yes, sir.

Q. Have you observed any thing on the ground, near the pipe, out of the way? — *A.* I did on the 12th of December.

Q. What did you see there? — *A.* Where it turns [B] to go up the hill, within about twenty feet of the angle and about four feet west of the conduit, I saw a sediment standing in the ruts.

Q. Was Mr. Barbour's description accurate? — *A.* Yes, sir.

Q. You got some of it? — *A.* Yes, sir.

Q. That was within about four feet of the conduit? — *A.* Yes, sir.

Q. How did it smell? — *A.* Very offensive.

Q. What else did you see that day, any thing? — *A.* Well, I saw the pipe uncovered in the afternoon, — same afternoon.

Q. Any matter on the ground? — *A.* I did not see any thing that day.

Q. When did you next see any thing out of the way? — *A.* I think it was next morning. I saw where the pipe had leaked, about twenty feet up the hill, and the sediment from it had spread around on the ground, — twenty feet above the point where the soup-pipe makes its turn, I saw a hole where it had washed out, and exposed the soup. I did not see any thing going out of it there then, for they were not pumping; but the stuff lying on the ground, around this hole, was very offensive: it was the color of chocolate.

Q. State whether that was around the ground? — *A.* It was spread over — [Interruption.]

Q. How far did it run down? — *A.* Until it struck level ground.

Q. How many feet? — *A.* About twenty.

Q. Was there much on the ground? — *A.* I did not see much of it after it got down here [level ground]; but up here [at the leak]was the smell.

Q. Did it smell badly? — *A.* Yes, sir.

Q. Did you see any thing else that day? — *A.* I don't recollect.

Q. When did you next see any thing out of the way? — *A.* The next observed was an offensive smell on the hill.

Q. When was that? — *A.* I think it was the same afternoon of the morning that I discovered it.

Q. Who was with you when you discovered this in the morning? — *A.* Our engineer and Mr. Barbour's man.

Q. You saw the muck-heap on that same day, did you? — *A.* I think it was in the afternoon; they had been pumping, and it was very offensive: I did not go very near.

Q. How near? — *A.* Thirty or forty feet.

Q. Was there a bad smell about it there? — *A.* Very; I started to go clear up, but concluded I would not go any farther.

Q. Why? — *A.* Because it was too offensive.

Q. Have you ever seen any thing else there on the line of that pipe? — *A.* I think not, sir.

Q. Have you observed in the vicinity of the slaughter-house any offensive smells? — *A.* Well, yes, sir: I almost always did in passing up the track.

Q. What track? — *A*. The railroad-track leading from the slaughter-house.

Q. Was there any smell there yesterday? — *A*. There was, when you passed through between the buildings.

Q. Live hog, or dead hog? — *A*. I did not stop to analyze the difference.

Q. Will you state generally, whether, since that slaughter-house has been in operation, the air in the vicinity has been pure, or whether it has been filled with bad odors? — *A*. I don't know that I ever went up there, but what I smelled it.

Q. Could you smell it from the railroad-track? — *A*. Yes, sir.

Q. How far from the buildings? — *A*. According to which way the wind was.

Q. The farthest you have smelled it? — *A*. There was one time we could smell it half-way down the road.

Cross-examination by MR. WARREN.

Q. You saw the pipe leading down the railroad-track when it was first laid? — *A*. I saw about twenty joints of it.

Q. In your opinion, was that laid as it ought to have been? — *A*. By no means.

Q. Did you know that at the time? — *A*. Yes, sir. It wouldn't have done for me — [Interrupted by MR. WARREN.]

Q. You were satisfied there would be trouble about it? — *A*. I was.

Q. Did you inform Mr. Boynton or anybody about it? — *A*. No, sir: I did not think it was my business.

Q. You know very well that the parties publicly proclaimed that any suggestion that they could get would be thankfully received, and that they would be obliged for it? — *A*. Yes, sir.

Q. And, instead of suggesting something which would relieve the difficulty, you let it go on that way, did you, and posted yourself as a sentinel to find out the first leak? — *A*. No, sir: I did not think I was employed for that purpose.

Q. You are superintendent of the water-works? — *A*. Yes, sir.

Q. As such, it is your duty to keep the water as pure as you can? — — *A*. Yes, sir.

Q. Did you see the soup-pipe, when it was laid? — *A*. I did not.

Q. You think the smell was very offensive going up the hill? — *A*. Yes, sir; between the two buildings.

Q. Was the dryer at work? — *A*. I do not know.

Q. Were you ever near the buildings when the process of drying was going on? — *A*. No, sir: that smell on the hill was like some dead animal, or carrion.

Q. You did not look to see? — *A*. No, sir.

By MR. HAMMOND.

Q. Did you see the drippings from the cars? — *A*. Yes, sir, I did, on the 10th; the rain was driving into them, and was washing out of the side very freely.

MR. E. C. BROOKS *called.* — *Direct Examination by* MR. HAMMOND.

Q. You are engineer at the pumping-house, are you? — *A.* I am, sir.

Q. Did you go with Mr. Nevons, and see any thing on the line of the soup-pipe? — *A.* Yes, sir: I went over to the slaughter-house on the morning of the 14th, and saw, about twenty feet above where the pipe turns, that there had evidently been a leak the night before; and a part of the water, about over the conduit, was clearly seen in the soil that had been covered over the pipe, down near the conduit. There was a lightish-colored scum collecting on the ground, and on the surface of the water, that looked as though it might be a dry froth or foam, from something that had been pumped there.

Q. The stuff came from the pipe with force enough to make a hole through the ground? — *A.* Yes, sir.

Q How far from the surface of the ground to the pipe was it, and how far did that stuff have to go before it got out of the ground? — *A.* Well I could not say.

Q. Could you see the pipe through the hole? — *A.* No, sir.

Q. Was that all? — *A.* On the day of the snow-storm, I went over to the outlet of the drain; and where the drain had been leaking, I heard they had been repairing it, — the drain leading from the slaughter-house down to Alewife Brook.

Question by MR. WARREN.

Q. How far was this leak in the soup-pipe up the side of the hill? — *A.* About twenty feet.

Questions by MR. HAMMOND.

Q. You feel confident it could not have been dug out? — *A.* No, sir.

Q. Had there been any rain that day? — *A.* There was water standing at the foot of the hill, nearly over the conduit.

Q. And had a greasy look? — *A.* It did.

Cross-examination by MR. WARREN.

Q. Did you go up the hill? — *A.* I did not.

Q. Did not see more than one opening, did you? — *A.* I saw the place where they had evidently dug before that, but think this is the place where the leak occurred.

Q. How large a hole was this? — *A.* About as large as my wrist.

Q. This pipe has all been taken up since? — *A.* I don't know.

JOHN TROWBRIDGE *called.* — *Direct Examination by* MR. HAMMOND.

Q. You are professor in Harvard? — *A.* Assistant professor.

Q. I will ask you whether you were not skating day before yesterday, on the Glacialis, in the afternoon? — *A.* Yes, sir.

Q. Was there any thing offensive in the air? — *A.* I smelled a very offensive odor.

Q. Can you describe it? What would you judge it to be? — *A.* It would puzzle me somewhat to describe it.

Q. Was it that of decaying animal matter? — *A.* It was the odor of

swine, mixed with something a little more offensive. It was not like pig odor alone.

Q. Pig odor discernible? — *A.* Oh, yes! I was there half an hour, and I noticed it all the time I was there.

Cross-examination by MR. WARREN.

Q. Are you familiar with the process of rendering animal matter? — *A.* I have a general idea.

Q. You don't know the process of drying animal scraps or blood? — *A.* No, I think not.

Q. I wanted to see whether the odor which you got could be recognized by you as the odor which proceeds either from rendering, or from drying animal matter? — *A.* It reminded me of an odor that is to be found around Ward's factory in Roxbury district, I think. Something of the same odor, I should judge.

Q. Whether in your judgment, in starting a tank at the first time, the leakage might have been met. Have you been up there before, this season? — *A.* No, sir.

Q. This was the first time this season? — *A.* No, sir.

Q. Day before yesterday? — *A.* Yes, sir.

WILLIAM RICHARDSON *called.* — *Direct Examination by* MR. HAMMOND.

Q. Your name is William Richardson? — *A.* Yes, sir.

Q. Reside in Belmont? — *A.* I do.

Q. Your place is near Wellington Brook, isn't it? — *A.* A part of it is on Wellington Brook.

Q. Your place is up north of this spot? — *A.* Yes, sir.

Q. Across the road leading from Concord Avenue towards Wellington Brook? — *A.* Yes, sir.

Q. What is the road called? — *A.* Brighton Street.

Q. You keep a large number of swine, do you not? — *A.* I keep some.

Q. How many have you now? — *A.* About seventy-five.

Q. Have you had, or has there been, any thing carted to your place from the slaughter-house? — *A.* Yes, sir.

Q. What was it? — *A.* I carted some "plucks," — mostly "plucks," but also some "livers and lights."

Q. Did not give you all the "livers," did they? — *A.* Yes, sir.

Q. How many loads did you take up there? — *A.* I don't recollect how many.

Q. How large a pile did it make? — *A.* That I could not tell. A layer of this, and a layer of that other matter.

Q. Did it cover your whole pig-pen? — *A.* I did not put it in the pig-pen.

Q. Where did you put it? — *A.* Into a heap.

Q. Where? — *A.* In my lower place.

Q. You did not offer it to your pigs at all? — *A.* I took them, because they wanted to know if I could take them, as they were blocked up.

Q. How many loads? — *A.* I could not tell you.

Q. Your best judgment? — *A.* I should not dare to say.

Q. Twenty-five? — *A.* Oh, no, sir! perhaps four or five or six. I filled the cart up to the rails.

Q. What kind of a cart? — *A.* A two-wheeled cart.

Q. What did you do with it finally? — *A.* I buried it.

Q. Well, in the heap or scattered? — *A.* I scattered it.

Cross-examination by Mr. Warren.

Q. You calculated to use it for manure? — *A.* Yes, sir.

Q. Mr. Boynton had got a little crowded at home? — *A.* Yes, sir.

Q. He had his place full of men working, and the dryer disappointed him, did it not? — *A.* Yes, sir.

Q. And so he got you to cart them away, didn't he? — *A.* Yes, sir.

George L. Cade *called. — Direct Examination by* Mr. Hammond.

Q. Do you reside in Cambridge? — *A.* Yes, sir.

Q. Did you go up and see this slaughter-house? — *A.* I did, sir.

Q. When? — *A.* I should think it was nine or ten days ago.

Q. Who with? — *A.* The superintendent of the water-works and the city engineer.

Q. Did you inspect the leak in the drain that runs into Alewife Brook? *A.* I did not.

Q. State what you saw. — *A.* I saw a pipe there, but did not go to the outlet of it.

Q. Was any thing objectionable? — *A.* Rather a strong smell.

Q. Where? — *A.* On the top of the hill.

Q. Did you see the muck-heap? — *A.* I did.

Q. Was there any thing — any odor arising from it? — *A.* Yes, sir.

Q. How long did you stay there? — *A.* We went over to Alewife Brook and partly up to Wellington Brook, and to the gate-house, and walked from there across. I should judge it took about one hour. I then went into the building.

Q. How long did you stay up on the hill? — *A.* Only a minute.

Q. Did you see the matter there in the muck-heap? — *A.* I did not, sir.

Q. Is that all you observed? — *A.* I saw some men at work there stirring it up. I did not go near the heap.

Q. Did you notice how it looked? — *A.* Not particularly.

Question by Mr. Warren.

Q. How near did you go to the muck-heap? — *A.* Should think, about fifty feet.

Q. Was it in use at the time? — *A.* I could not tell, sir.

Q. Was it warm, or cold? I mean the heap. — *A.* I don't recollect how it was.

Q. Are you superintendent of streets? — *A.* I have been, not now.

Professor Wood *called. — Direct Examination by* Mr. Hammond.

Q. Your name is Edward S. Wood? — *A.* Yes, sir.

Q. Will you state your profession? — *A.* I am

in the medical college in Boston, which is connected with Harvard University.

Q. You have heard the testimony here by Mr. Barbour with reference to the experiments he made with regard to the geological formation around the pond? — *A*. I have heard the testimony; yes, sir.

Q. I will ask you whether, in your judgment, such matter as comes from the slaughter-house may safely go into Fresh Pond. — *A*. Matter which comes from any slaughter-house naturally would not be fit to go into that pond.

Q. Have you made experiments for the city of Boston as to their water-supply? — *A*. I was one of the water commission.

Q. When? — *A*. 1874 or 1875, I forget which.

Q. Of whom did the commission consist? — *A*. It consisted of Drs. Bowditch and Swan and myself.

Q. What did you have occasion to investigate then? — *A*. The waters of the Charles, Mystic, and other rivers, in order to determine what was the best source of water-supply for Boston.

Q. In that time you had occasion to judge what would defile water, and what would not? — *A*. Yes, sir.

Q. How long were you there? — *A*. Six months, I should judge.

Q. Have you made investigations from time to time since then? — *A*. Yes, sir: I have kept up my interest in it.

Q. I will ask you, Professor Wood, whether, in your judgment, the contamination of the soil in this case would not be likely to reach Fresh Pond? I mean the contamination from the slaughter-house. — *A*. Yes, sir: I should think it was a matter of time, sir. Animal matter going through gravelly soil is liable to saturate it in time.

Q. Is the soil here gravelly? — *A*. Yes, sir; all I am familiar with.

Q. You presume it to be a gravelly soil with a tendency towards the pond: do you believe that the earth could be saturated without in the end reaching the pond and affecting it? — *A*. No, sir.

Q. Whether or not water may be contaminated by poisonous animal matter so as to be unfit to drink, and yet not to be detected by a chemist? — *A*. It is an acknowledged fact that it is a possible thing.

Q. Poison may result from animal matter getting into the water; that is, water may be in that way poisoned? — *A*. Yes, sir.

Q. So that chemical analysis would not detect it? — *A*. Yes, sir.

Q. How, then, would it be ascertained by the results to the human system? — *A*. In the production of sickness.

Q. It is acknowledged to be a fact among medical men? — *A*. That is the prevailing opinion.

Q. How about animal excretions? — *A*. Animal excretions are considered to be the most liable to affect water.

Q. You have been upon the ground? — *A*. Yes, sir.

Q. For the purpose of seeing how things were? — *A*. Yes, sir.

Q. Did you observe any thing about the buildings that you thought was objectionable? — *A*. I saw where the pigs were: I supposed their piggery was leaky. I looked down the back side, and there were large icicles containing yellow matter, running down the side of the windows

in the first story of the pig-pen at the bottom, on the upper portion of the sash in the rear.

Q. And you judge from its appearance that that contained fœtid matter? — *A.* Yes, sir.

Q. Did you look inside? — *A.* Yes, sir; through the windows.

Q. What did you see there? — *A.* I don't remember accurately: there were pigs and hogs in sort of pens.

Q. Was there any odor about the premises? — *A.* Yes, near the buildings.

Q. How far could you discern it from the buildings, should you think? *A.* I don't recollect accurately, sir: it was in the immediate vicinity.

Q. Live hog? — *A.* I should say so.

Q. Did you go upon the muck-heap? — *A.* I did, sir.

Q. Did you judge how large it was? — *A.* I could not describe its size: it was quite extensive.

Q. How has that been considered a success, — that method of disposing of the products of a slaughter-house, as far as you know? — *A.* I don't know, sir.

Q. Have you ever heard of that method in this country before? — *A.* In fact, I don't know any thing about it.

Q. I will ask you how the lay of the land looked there; and, from what study you have been able to give to the subject of this matter here, do you think that the matter from this muck-heap would be in danger of getting into the pond? — *A.* I should think, — or should be very much afraid — of its getting into Wellington Brook, and, if into Wellington Brook, of course it goes very directly into Fresh Pond.

Q. I will also ask you whether you believe the slaughter-house can be carried on without danger of contaminating the water of Fresh Pond. — *A.* That I should not dare to answer, — as to whether it *could* be carried on or not.

Q. Whether the present way of carrying it on is without danger? — *A.* I should be a little afraid of exposing the offal in that manner.

Cross-examination by Mr. Warren.

Q. In what manner do you understand the offal is disposed of? — *A.* I don't mean the offal, I mean the soup.

Q. You understand what the constitution of the soup is? — *A.* No, sir: I don't.

Q. In the process of rendering, you get three products, — the solid animal, the greasy, and the soup; soup being of the same kind that you get in boiling a piece of meat or pork in a pot: how much of that soup is of pure water, and how much animal matters? — *A.* It must contain some animal matter, but I don't know how much.

Q. Do you know how much water, pure water, a cubic yard of loam will absorb before it is saturated? — *A.* I could not give you any answer: I should say, considerable.

Q. I am informed that there are about twenty-six hundred cubic yards of muck-beds; could you give any idea of the quantity of water that will be absorbed by them when it was tried? — *A.* No, sir.

Q. Did you see a three-inch pipe through which it is conducted? — *A*. Yes, sir.

Q. Do you suppose that the muck-heap would absorb one hundred gallons of water? — *A*. I could not answer, sir, because I do not know what the absorptive powers are.

Q. Of course, the danger of injury to the waters of Fresh Pond from that slaughter-house depends entirely whether the animal matter gets into the soil? — *A*. Certainly.

Q. You don't imagine that a barrel of that soup going into a body of water of 1,113,294 gallons would have any perceptible effect? — *A*. I would not care to have a barrel-full of any kind put into my drinking-water.

Q. Suppose if this soup product were turned in fresh into the water, is there any thing deleterious in that? — *A*. Probably not.

Q. If it goes into a pond where it is diluted in many million gallons of water, would it ever have any deleterious effect? — *A*. It would be decomposed after it got into the water, naturally, by many changes of the different seasons, and the exposure to the sun and snow, &c.

Q. The deleterious effect would depend upon the relative quantity of animal matter and the water in which it is diluted? — *A*. Not entirely: I think it would depend upon the quality also.

Q. I mean, taking the same matter. — *A*. Yes, sir.

Question by MR. HAMMOND.

Q. Do you think it would be a good plan to pour this soup into the pond right along? — *A*. No, sir.

STEPHEN P. SHARPLES *called.* — *Questions by* MR. HAMMOND.

Q. You reside in Cambridge? — *A*. Yes, sir.

Q. What is your profession, sir? — *A*. A chemist.

Q. Have you made analyses of Fresh Pond water frequently? — *A*. Yes, sir; since the early part of 1875.

Q. Are you familiar with the location there? — *A*. Yes, sir.

Q. You have heard Mr. Barbour's testimony and belief regarding the result of his experiments there? — *A*. I have.

Q. I will ask you whether the contamination of the soil there by animal matter, in your judgment, is safe for those who drink Fresh Pond water? — *A*. I should not think it would be.

Q. Have you recently visited the premises? — *A*. I was there yesterday.

Q. What did you observe? — *A*. In going up there the first thing I observed was that a strong smell of the establishment could be quite distinctly noticed on Concord Avenue, at the brook, just as we passed the brick house. I will also state that my nose was not in very good order, but I could smell that, yesterday morning.

Q. Have you looked at those muck-heaps? — *A*. I have.

Q. Do you believe that experiment practical? — *A*. I should not want to carry it on as it is now. The ground is frozen hard to a considerable depth.

Q. What do you think of brother Warren's question about pouring soup into the water? — *A.* I will say we could find the effect of a barrel being put into the one million gallons : I have made experiments on this subject at Squires's place. This soup contains about ten per cent animal matter: it may run a little more or less, but that is about the average. That animal matter contains upwards of seventeen per cent of nitrogen, it being one of the most nitrogenous substances we know of; and putting that amount in the water would be quite likely to contaminate the conduit.

Q. I understand you to say that if the ground should be contaminated it would be likely to contaminate Fresh Pond? — *A.* I think it would be, especially if the lining of that pond is broken through, or if the gravel this side of it is disturbed. I have made no examination of their drains.

Q. Pickle put into the pond finally putrefies? — *A.* Yes, sir, to some extent: it contains a considerable amount of animal matter, — liquor in which hams and pork have been pickled.

Cross-examination by MR. WARREN.

Q. Do you mean the brine that is made to put on the hams, &c.? all the pickle that goes into the drain is what is not used. — *A.* Yes; but it is what has been used: as a general thing, after they pickle hams the pickle begins to smell, and it is thrown away; it gets so charged with animal matter.

Q. The soup would be excellent for a fertilizer; would it not be? — *A.* Yes, sir. I have been laboring for years to get it used for that purpose.

Q. Why could not you get it used? — *A.* Because of its intolerable stench. It could not be carted on account of the blowing-up of the tanks. Squires tried, and had trouble. He tried hauling some over to Brighton. The next trouble is that the substance, which contains seventeen one-thousandths of nitrogen, would hardly pay to evaporate for the purpose of obtaining the solid matter.

Q. I believe that Mr. Boynton and Mr. Niles went to see you about the matter before the building of the slaughter-house was commenced? — *A.* Yes, sir.

Q. Did you not recommend this plan of making muck-heaps? — *A.* I said that if they insisted on this plan of building they could not run off that soup through sixteen hundred feet of pipe; that I thought the absorption by dry peat was probably the best system, but that if the muck-heaps were not kept thawed during the winter it would be bad.

Q. And did not you tell them that, with certain changes which you suggested, they could get along? — *A.* I told them before the hearing that I was very sorry to see the slaughter-house there, and that, while the slaughter-house might possibly be theoretically carried out, I did think that practically it was impossible.

Q. Did you make any suggestions? — *A.* I may have made suggestions that the cellar should be thoroughly cemented so that the slops could not get through. I have never been in their employ about it.

Q. As a matter of fact, has not the soup been very constantly carted,

and is it not done now? — *A*. I don't know of any place where it is carted.

Q. I suppose if, in any season, the mixture with the muck could take place, so that it can be carted away immediately, there would be no trouble about it? — *A*. I think there would be no trouble if it was carefully mixed with a sufficient quantity of dry earth.

Q. But you don't know of any way how that can be managed? — *A*. No, sir.

Q. Nothing is said about the pond that would make you apprehensive that the waters have suffered from the slaughter-house as yet? — *A*. No, sir : not at present.

Q. Only apprehension from the soup? — *A*. Yes, sir. Only that.

Q. Suppose this soup to be on top of this hill, and some of it, containing this animal matter and this nitrogen, gets into the soil, and percolates through the soil, twelve hundred feet to the brook: would not the soil absorb all the animal matter before it had proceeded that distance? — *A*. It would probably: that is not the danger; the greatest danger is about its being washed in from rains.

Q. Would not percolation of six thousand feet clear pretty much all kinds of water? — *A*. No, sir: not after the soil becomes saturated.

Q. If it is cultivated soil, doesn't the soil take up the nitrogenous matter? — *A*. Yes, sir.

Q. Then in case of accidental leakage it would probably be many years before any thing deleterious could be sustained? — *A*. It is from ultimate damage we must provide for in the start: it might be five or fifty years before any thing would result of a damaging nature.

Q. The only occasion of the interference now is, that, at some future time, the danger will happen? — *A*. That is about it.

Q. Can you recommend any better plan than is now adopted for the soup? — *A*. I had rather not make any suggestions.

Q. Do you occupy any official position in Cambridge? — *A*. I do.

Q. What is the reason you didn't think it proper to be employed by Niles Brothers? — *A*. Because I was employed by the city of Cambridge, and have been connected with the water-supply.

Q. I don't understand you: you understood that they desired to employ you only because you are a chemist, and you would be the proper man to employ, I think? — *A*. I drew my own inferences.

Q. If you draw such inferences I would like to know it. — *A*. I had rather not explain at present.

Question by MR. HAMMOND.

Q. I suppose that the first intimation that we would have of the fact of the contamination of the pond would be upon the persons who had drank the water? — *A*. Yes, sir.

(Hearing was here adjourned until Saturday, Dec. 21, 1878, at ten A.M.)

SATURDAY, Dec. 21, 1878.

MR. BARBOUR *recalled.* — *Questions by* MR. HAMMOND.

Q. The Board has desired to know the height of the little pond out there, so as to have what light we could upon the No. 5 well. Have you made any examination since yesterday's hearing? — *A.* Not since the hearing: I have taken other levels farther down. I have the notes. The elevation in this pond is 15.81, our base being 5.62 feet below mean low tide-water: this was the 19th of December. I find some levels taken on the same spot on the 12th of December, with only a slight difference. The level is 15.89 at that point near the meadow.

Q. Now, what was the height of well No. 5 at that time? — *A.* I have not had the use of No. 5 since Dec. 3. On the 2d of December the height of well No. 5 is 15.82 (the water in the pipe), and the highest point No. 5 has reached at all in my observations is 16.16.

Q. Now, what measurements have you made about here? Perhaps the gentlemen of the committee would like to know. — *A.* Dec. 12 Fresh Pond was 14.61; Dec. 19 it stood the same, 14.61.

Questions by Mr. WARREN.

Q. Any between these dates? — *A.* Yes, sir.

Q. Take from the 12th to the 19th, how does the pond level vary? *A.* I will give you the levels as I have noted them.

Dec. 12	14.61
" 13	14.62
" 14	14.61
" 15	14.63
" 16	14.64
" 17	14.63
" 18	14.63
" 19	14.61

These are the levels of Fresh Pond.

Q. Doesn't it run back for a week or two before, about the same way? — *A.* Dec. 8 it was 14.30, and Dec. 1, 14.19; Nov. 25 it was 14.07. The rain had raised the pond nearly a foot from the 14th of October to the 19th of December.

Q. What is the level of the pond this morning (Dec. 21)? — *A.* 14.61.

Q. What of the Glacialis? — *A.* 15.14 at the south-east corner, and at the junction of Alewife Brook with the end of the drain [K], 14.58. On the line of the drain-pipe towards the outlet, 1,725 feet from the slaughter-house, I took levels on the meadows, on each side of the railroad-track; the level on the north side was 14.98, and on the opposite side 15.19. In the little pond [behind P], it was 15.87.

Q. Do you know whether in pumping out Fresh Pond three or four years ago, it affected the surface of Spy Pond? — *A.* I think it did not. Fresh Pond has been down below grade ten (10).

Q. Been down below the pumping-pipe? — *A.* Not the present one.

Q. How low would it have to be to expose the top of the other? — *A*. I think the top of the present pumping conduit is at grade nine. In 1876 the water was down so low that the conduit between Fresh and Little Ponds was not more than half full. At that time I was able to send "floats" through.

Q. Then it would have been three or four feet lower than now? — *A*. Yes, sir: might have been two and a half feet lower.

Q. During the rise of a foot in the pond, did you observe any change in the condition of the water in the pond? — *A*. I have not made any examination of that.

Q. Have you ever noticed whether there is any difference in the purity of the water of the pond after these heavy rains? — *A*. I have not, sir.

Q. I should like to have you give, beginning at the rear here, the levels down to that point. These figures indicate the levels taken by you at a certain date (Aug. 30). Are these correct? — *A*. Yes, sir.

Q. That line is a line of levels of the standing water all down here to the brook: it follows the depression. What are the general levels taken on the same day, beginning at the point where we now begin, and terminating at a place below? — *A*. I will commence near Fresh Pond (Aug. 30). In the gravel-bank on the west side of the conduit, westerly from the slaughter-house, 14.64.[1] The next level is taken in the foundation of the trench of the slaughter-house, on the east side of the conduit, 14.67. The next is a point northerly from the hog-house, 15.10. A little farther north, in the same swamp, 15.48. The next is at the culvert on that part of the road through the Tudor estate, northerly from the slaughter-house, 15.25; on the west side of the road, and on the opposite side (eastern side), is 15.03. The next was at a culvert under the main railroad-track; on the south side of the road it was 15.31, and on the north side, 15.26. The next one is northerly six hundred feet on the line of the ditch, and is 15.17. The next we turn, and go easterly four hundred feet, and it is 15.02. Continuing in the same direction eleven hundred feet, and it is 14.47. Now, continuing in the same direction two hundred feet farther, and it is 14.27. The next is at the junction of the Little River and Alewife Brook, and is 13.99. And four hundred feet southerly towards the pond in Alewife Brook, it is 14.03. That was all surface water, except in the case of the first two, which were the levels of the ground-water in the gravel-bank [now excavated].

Question by Mr. Hammond.

Q. You took that line[2] because you supposed that was where they were going to put their drain? — *A*. Yes, sir.

Mr. Warren *resumes*.

Q. That shows a constantly decreasing water level from this vicinity [P] to Alewife Brook? — *A*. Yes, sir.

[1] See the map.

[2] In a general way, from the vicinity of the slaughter-house to the junction of Little River and Alewife Brook.

Q. That is what you call the water level?—*A*. That is the level of the water, as I find it in those ditches, and not ground-water level.

Q. Is that the water level?—*A*. It is the surface-water level, that was standing on the meadows and in the ditches. The levels might vary in other ditches.

Q. What was the use of taking those levels at all?—*A*. They were taken for the purpose of determining the water as it lay on the meadows and ditches at that time, and in order to determine whether there was a fall that way for drainage.

Q. Those different levels would certainly indicate the direction in which the water was moving?—*A*. It would indicate that there was a surface fall towards Alewife Brook, on the meadows.

Q. Is it a fair comparison, for any purpose of yours or mine, to compare water which we reach in a trench, and which is underground water, with surface-water, which we find on the meadow? Can you draw any comparison from surface and underground-water levels?—*A*. No, sir, I should say not.

Questions by MR. HAMMOND.

Q. Alewife Brook is about four feet wide there?—*A*. Rather wider.

Q. How wide?—*A*. Six to eight feet.

Q. How deep at that point?—*A*. I should say about two feet at that time (August).

Q. Sluggish or rapid?—*A*. Rather sluggish.

Q. As a matter of fact, the surface of Fresh Pond is below high-water mark?—*A*. Yes, sir: it is now.

Q. It is high for the pond?—*A*. Yes, sir: it is high for this season of the year.

Q. How low is the surface of Fresh Pond below high-water mark now?—*A*. 2.24 feet.

Q. Does any water from Fresh Pond go now into Alewife Brook?—*A*. Not that I know of.

Q. And so the only water that this brook gets is the water surrounding here?—*A*. That is all.

Question by MR. WARREN.

Q. Except sewage?—*A*. Yes, sir; except that.

CHESTER W. KINGSLEY, *called.*—*Direct Examination by* MR. HAMMOND.

Q. You have been a member of the Water Board of Cambridge for some ten years?—*A*. Yes, sir; ever since they had water-works.

Q. You have been president of that board a certain portion of the time?—*A*. Yes, sir.

Q. You are a member now?—*A*. Yes, sir.

Q. In 1875, do you remember whether the water was drawn down very low?—*A*. I couldn't say, that year. I think it was 1873 or 1874.

Q. How much lower than it is now?—*A*. I don't know that I know. I should think about six feet below what it is now.

Q. Now, as to bearing upon the question of the connection between Spy and Little Ponds,—some unseen underground connection, did

drawing down that pond affect the level of Spy Pond? — *A*. It did not.

Questions by Mr. Warren. — *Cross-examination.*

Q. I want to ask about that Spy Pond: is it very generally contended that the lowering of one pond lowers the other? — *A*. It was supposed so until we had that dry time.

Q. What difference was there in the difference of the levels at that time? — *A*. Spy Pond was four feet higher than the other.

Q. You were pumping all the time? — *A*. Yes, sir.

Q. When did you first learn that there were sewers running into Alewife Brook? — *A*. When they were first built.

Questions by the Board.

Q. Please tell us whether the water in these swamps in this neighborhood was drawn down at that time. — *A*. Yes, sir. The swamps were quite dry.

Q. Did you take the level in any of the swamps, so as to know the relative difference? — *A*. No, sir; we didn't.

Q. Do you think they were about the same level? — *A*. I have no means of knowing.

Questions by Mr. Warren.

Q. You know they were lower than usual? — *A*. Yes, sir: we tested that in the gravel-bank. They followed with Fresh Pond. They were not exactly on a level with Fresh Pond, somewhat higher; I think from three to four inches; it depends on the weather being wet or dry. There was more difference in the wet weather, than in the dry weather.

Q. They were never on a level? — *A*. No, sir; I never knew them to be.

Q. Did you ever know the difference less than six inches? — *A*. Yes, sir; I think I have.

Question by the Board.

Q. Have you seen, in Fresh Pond, any thing of impurity coming from the slaughter-house in any way? — *A*. No, sir: I have never seen any thing of that kind.

Q. When the pond was very low did you notice any percolation through, on the borders of the pond? — *A*. No, sir: I don't think I did.

Question by the Chairman of the Board.

Q. You were president of the Water Board. I want to ask you whether at any time you have seen any thing coming from the conduit that was impure. — *A*. No, sir: I have not.

Remark by Mr. Hammond.

I shall introduce no chemical analysis to show that we detect the impurities of the slaughter-house in that pond.

Remark by Mr. Warren.

You don't pretend that there has any thing got into that pond yet, do you, sir? — *A*. I don't know (by Mr. Hammond).

Joseph B. Barker *called.* — *Direct Examination by* Mr. Hammond.

Q. You reside where? — *A.* In Belmont.

Q. Is your house the nearest house to the slaughter-house? — *A.* With the exception of some lately building there.

Q. Aren't you nearer than Mr. Black? — *A.* About equal distance: about fifteen hundred feet off.

Q. How long have you resided there, sir? — *A.* My family have resided there for ten (10) years; my father's family, ever since I was fourteen (14) years old.

Q. I want to know whether you notice any smells, since the establishment of that slaughter-house, that you didn't notice before. — *A.* Certainly.

Q. How constant are they? — *A.* Almost every day.

Q. Does the direction of the wind make any difference? — *A.* We 'most always have the smell: the wind does not appear to make much difference.

Q. Is it agreeable, or otherwise? — *A.* I don't fancy it.

Q. What does it smell like? — *A.* Hog-pen smell.

Q. Alive, or dead? — *A.* I don't know that I could distinguish one from the other.

Q. Is it an odor which you never distinguished before? — *A.* Yes, sir.

Q. Is it remarked in your family? — *A.* They have often spoken of it.

Q. How does the ice which is drawn from Fresh Pond rank with other ice? — *A.* Always ranks highest of any in the market.

Q. Is the ice-business extensive on that pond? — *A.* It is.

Q. Is the ice from the pond circulated, or carried away, and used here? — *A.* Yes, sir; a great deal used about here, and sent to the East Indies also.

Q. Carted around in carts? — *A.* Yes, sir.

Cross-examination by Mr. Warren.

Q. You are in the employ of the Tudor Ice Company, are you not? — *A.* Yes, sir.

Q. What position? — *A.* Foreman of the ice-cutting.

Q. In the ice-cutting season, how many horses do you use on the pond? — *A.* Sometimes ten (10), sometimes sixty (60).

Q. How many does Mr. Hittinger use? — *A.* About an equal number.

Q. Cut as much ice as you do? — *A.* Yes, sir.

Q. What other companies are there around the pond? — *A.* Ames and Black.

Q. How many horses do they use on the pond? — *A.* Well, say ten (10) or a dozen (12).

Q. How many men do you use all put together, when you are cutting ice? — *A.* From twenty (20) to sometimes three hundred (300).

Q. In your company alone? — *A.* Yes, sir.

Q. Equal number in the other companies? — *A.* Yes, sir.

Q. Those men and horses are on the pond all day? — *A.* Yes, sir.

Q. Sometimes all night? — *A.* Yes, sir: very seldom, however.

Q. In the winter season, there is skating on the pond? — *A.* Yes, sir.

Q. A great deal of it? — *A.* Yes, sir.

Q. Is there ever any driving on the pond, with horses and sleighs? — *A.* Very seldom.

Q. People fish through the ice a great deal, don't they? — *A.* It is objected to as soon as we find it out, as it destroys our business.

Q. You don't make them believe they are obliged to leave? — *A.* Never tried to drive anybody.

Q. Now, you say your ice commands the best price in the market, and is the purest ice there is: were you aware that ice on the surface[1] may be very pure while the water is exceedingly impure? — *A.* I haven't looked into that matter a great deal, but should rather take pure water than impure, for ice.

Q. You say you *have* detected some odor like a hog-pen. When did you first observe it? — *A.* Well, I can't name the particular time. It has been for the last fortnight or three weeks: I don't know but farther back than that.

Q. It makes no difference which way the wind is? — *A.* In a strong wind I don't notice the smell so much. I can notice it almost every day.

Q. Well, say the first time was two (2) or three (3) weeks ago? — *A.* It might have been: I didn't take any particular notice of it. I suppose it to be about that time.

Q. Has there been any difference in it, or character of it, on different days? — *A.* I don't think I have noticed any, particularly.

Q. You don't say that you have observed it every day, but almost every day? — *A.* Yes, sir; almost every day.

Q. What time in the day was it? — *A.* I don't know as there was any difference in the time of the day, although I have the impression I have noticed it most at night.

Q. Are you at home every day much? — *A.* I have not been a great deal, no, sir: not until within a fortnight.

Q. You don't notice it in the morning? — *A.* Not a great deal.

Q. You don't notice any different smell in the morning from night? — *A.* No, sir.

Q. Always the same kind of a smell. But you don't notice it so much in the morning: have you not noticed it on one or two particular days more than you have other days? — *A.* Yes, sir: sometimes.

Q. Say on one or two days, has not it been stronger? — *A.* I don't know as it was on one or two days; but there are times when it is stronger than at others.

Q. You did not know what was going on at the slaughter-house? — *A.* No, sir.

Q. When was your attention first called to the matter of smell? — *A.* Well, it might have been a fortnight ago.

Q. Who called your attention to it? — *A.* My own sense of smell.

Q. Anybody ask you to observe it? — *A.* No, sir.

Q. Have you been over there? — *A.* I was there once.

Q. When was it? — *A.* Last Sunday.

[1] See results of chemical examinations on p. 120.

Q. See any thing going on? — *A.* No, sir; nothing more than some mechanics at work around there.

Questions by the CHAIRMAN OF THE BOARD.

Q. Does this smell ever make you sick, or any of your family? — *A.* No, sir.

Q. Ever nauseate anybody in your house? — *A.* I have heard none of them speak of it in that way.

Q. In your account there must be some sixty (60) or one hundred (100) horses on the pond at once? — *A.* Yes, sir: there are times when there are probably one hundred horses on at once.

Q. They are urinating and passing the contents of their bowels, around them, constantly, are they not? — *A.* Yes, sir.

Q. Is any thing done to prevent that impurity from getting into the ice? — *A.* Yes, sir: we always keep a man around gathering it up, on purpose for that business.

Q. It is taken up immediately, is it not? — *A.* Yes, sir.

Examination by MR. WARREN *resumed.*

Q. Where is it put? — *A.* On the shore of the pond.

Question by the BOARD.

Q. The urine can't be taken up? — *A.* No, sir: not wholly.

By MR. WARREN.

Q. The ice is floated up on the water, is it not? — *A.* Yes, sir.

Q. It has a chance to get washed at that time, don't it? — *A.* Yes, sir: a man scrapes the top almost always before it goes up into the ice-house.

Q. The pond has to take what is scraped off of the ice? — *A.* It is put on the shore, or the land.

Q. But before you take your ice and scrape it, you float this ice along until you get it toward the elevator; and then, before you take it up, don't you have the scraper go across it? — *A.* Brooms and scraper.

Q. It is brushed off into the water? — *A.* Yes, sir.

Q. It is the last cleansing that the ice gets? — *A.* Yes, sir.

Question by MR. HAMMOND.

Q. You have seen the matter along the line of the drain? — *A.* Yes, sir: where they were digging out the pipe a short time ago.

Question by the CHAIRMAN OF THE BOARD.

Q. What arrangement does the city make with these ice-companies? — *A.* (*by* MR. HAMMOND). It is impossible for us to make any with the ice-companies, as you may be aware of the fact that, some years ago, the adjoining land-owners came to the conclusion that they owned the bottom of the pond, and they have had a plan, where the lines run from the boundary or circumference towards the centre, something after the shape of a pie, each one claiming his share; they confirmed that decision with mutual deeds of claim to each other; until within two or

three years, the ice men had always claimed that they had perfect claims to the ice. It has since been decided, however, in a case brought by one of these ice men against another, that that decision was void, and conveyed no rights in law, and the people have a right to take ice; and the courts say that anybody can go on that pond and cut ice, who can properly get there; but these ice people own the land bordering on the pond, and we have no control over them.

CASE OF RESPONDENTS.

Remarks to the State Board of Health by MR. WARREN.

I don't propose to take any time in opening this matter. The whole question has been discussed so often before your Board, that I don't think it is necessary for me to undertake to make any statements. I propose to furnish what evidence I can, to aid you in ascertaining the exact facts about this building, and about the circumstances which bear upon the application of the city of Cambridge, at the present time; and for that purpose, I propose, without formally putting them in, to place before the Board the official documents of the city of Cambridge, for the years 1875, 1876, 1877, and 1878, from the reports of the Water Board. I take those, because they are the official reports of the Water Board of the city itself; and in closing, after putting the evidence in, I propose to read some extracts from them.

In regard to the condition of the water, I shall also refer the Board to documents of Dr. Cogswell published in the last volume of the annual reports of the State Board of Health; and I shall also call as a witness the civil engineer, to add to the facts as produced by Mr. Barbour, and shall call the architect of the building to show the mode of construction, and shall call Messrs. Boynton and Niles to show what pains and care was taken in the construction of the building, and how they came to build there, and what their belief was in regard to the carrying-on of the business, and shall admit cheerfully that two mishaps have taken place, one in the drain-pipe, and one in the soup-pipe. They were accidents which were liable to occur in getting new machinery, and which, if cured immediately, could furnish no ground for complaint. You have not a particle of evidence that any contamination of the water has taken place, and of course it would be absurd to pretend that any such thing has happened. I shall show by Messrs. Boynton and Niles what circumstances caused these accidents; and that the smells to which people have testified were no doubt occasioned by the fact that a delay or interruption occurred, while these pipes were undergoing repairs. Then I shall ask Professor Nichols to state the conclusion to which he has arrived; and I think I can satisfy the Board, that there is no cause for apprehension, on the part of the city of Cambridge, even at the worst, for a considerable length of time; and before any reasonable ground of apprehension could exist, any evils will be corrected.

L. V. Niles *called.* — *Direct Examination by* Mr. Warren.

Q. You are one of the firm of Niles Brothers, and have had more to do with this building than your brothers? — *A.* Yes, sir.

Q. When did you first bargain for this piece of land? — *A.* I don't know as I can give you the exact date.

Q. Well, I don't care any thing about the exact date. What time in the year? — *A.* About the first of August, 1878.

Q. How soon did you commence operations? — *A.* Well, I should think we had a surveyor go there within two or three days after we made the bargain.

Q. Before making the bargain did you, or any one of you, go and call on the selectmen of Belmont? — *A.* Mr. Boynton went.

Q. From what you understood took place, you proceeded to lay the foundations? — *A.* Yes, sir.

Q. When did you first find any opposition, and from what source? — *A.* Well, the first I heard was a report that the Tudor Ice Company was making objections; and on that day, I saw the chairman of the selectmen of Belmont.

Q. Did you ascertain from him, whether or not permission had been given you? — *A.* I asked him if they granted a permission, and he said "Yes." I asked him if I hadn't ought to have a written one, and he says he didn't "consider it necessary." I replied that that was something there should be no question about. "Well," he said, "I think there is no question, you don't require a written permit: we have given you all the permission we think you require."

Q. When next, after you heard complaint from the Tudor Ice Company? — *A.* The next we heard was a request from the city of Cambridge to meet them.

Q. You went there, did you, to the Water Board? — *A.* Yes, sir: before we — When this opposition showed itself we hadn't closed all our contract, and had invested but a small amount of money. Our business friends recommended the place, that there was nothing objectionable to it, and that it was a very favorable location; and, as not knowing that the city of Cambridge would make any objections, we commenced to lay the foundation of the building; but when I heard of this report that there was an objection on the part of the city of Cambridge, and that there was danger there, I told my brother I did not think it was safe to go on any further, without the advice of some professional man, and a man who was an expert. We consulted together as to who was the proper man to go to: we decided to call Professor Sharples, he being a Cambridge man, and at that time we wanted to be safe, and didn't want to take any chances whatever; and he would be the safest man for us to get advice from, as he must be prejudiced in favor of the city. Mr. Boynton and I called on him, and told him what we proposed to do. His answer was, "We don't want you there." Mr. Boynton said, "We don't want your advice here: we want you to go on to the ground, and look the matter over." He said he would go "to-morrow morning." We made arrangements to take him over the next morning. I went out on the train, and got out about nine o'clock: when I got there Mr. Boyn-

ton and Professor Sharples had been down as far as they could go, and turned. [Witness was here interrupted by MR. HAMMOND, who thought the description about the wanderings of Mr. Boynton, &c., was unnecessary.] And when he returned, he came and sat down, and we talked the matter over a few minutes. "Now," says I, "what is your opinion of this place?" and he says nearly these words: "You cut a drainage down through the meadow, under the Fitchburg Railroad, and get permission to pump the soup to that hill there, and cement your cellar thoroughly, and see that the pens and house are thoroughly tight, and I see no danger whatever."

Q. You went on then? — *A*. Yes, sir: it was on that decision that we decided to go on with the business.

Q. Then was there any other interference, until they learned you had not a written permit? — *A*. No, sir. The city of Cambridge requested us to appear before them.

Q. And you did? — *A*. Yes, sir.

Q. Something has been said that the first plan you stated to the city of Cambridge was not like the one that was followed out? — *A*. We made a change at Professor Sharples's suggestion: he said he should prefer to have the box-drain carried through the meadow, and we thought we would just as soon do what he thought best.

Q. At the hearing, was that box-drain mentioned as a part of the plan? — *A*. I can't say.

Q. They brought suit against you in the Supreme Court, on the ground that you had no permit? — *A*. Yes, sir.

Q. State whether or not you got the approval of a large number of the citizens of Belmont? — *A*. We got the names of over three-quarters of the voters of that town.

Q. And the selectmen gave you the license? — *A*. Yes, sir.

Question by MR. HAMMOND.

Q. What is the date of it? — *A*. I can't give the date without giving the original document. [Witness presents the license. See p. 117.]

(By MR. HAMMOND.) Dated Sept. 10, 1878.

MR. WARREN *resumes*.

Q. You procured the license, the suit was abandoned, and you went on and completed the building? — *A*. Yes, sir. But before doing so, after we got the permit from the selectmen, at the advice of friends, and our own regard for our own interest, I thought if there was a possible doubt I wanted to know it then; and I took quite a number of men of the best judgment, and who went there with some prejudices, on to the grounds, and I was not able to find a man to tell me there was any danger, only the prejudice of the city of Cambridge.

Q. How much money have you expended there? — *A*. I have not got our books figured up very closely. Our estimates were thirty thousand dollars ($30,000). I should think, owing to the expenses in cementing our cellar and other things, with all, it will probably exceed that by two to four thousand dollars.

Q. That has been expended on the strength of your belief that this management would be perfect? — *A*. Certainly.

Q. When you first began it, every thing worked right? — *A*. Since we commenced business?

Q. Yes, sir. — *A*. No, sir.

Q. When did you begin, about when? — *A*. I couldn't give you the exact date. I should think, something over four weeks ago.

Q. Were you in expectation, when you began, that every thing would be in readiness? — *A*. We did. We didn't intend to do any business until we had every thing ready; but there were delays that we had not expected.

Q. On whose part? — *A*. On the part of the machinery, the dryer, and then there were others. In regard to this drain, we had got that laid, and it proved that we had made a mistake in the calculation. We thought there would be a sufficient force of water to carry it off without any other force. We thought that there was difference enough in the grade, to get a fall sufficient to carry off the water. On account of the high pressure of the water at Alewife Brook, the drainage would not run off, and we had to put on pressure with a pump; but the drain was not laid to bear pressure, and leaked at the joints. As soon as we found it was leaking, we had it taken up and leaded the whole length, so that it is strictly tight, and has been ever since, with one exception, as was explained here yesterday; where there was a "T" put in, it leaked a little.

Q. You use pressure now? — *A*. We have got it arranged now, so that the water is pumped back into a cask, and it does not require pressure; that gives about six (6) feet more fall, and it runs off readily.

Q. After the water has gone into the filter-basin,[1] it is pumped back? — *A*. Yes, sir.

Q. That, so far, carries it off; and it was the application of pressure that forced the joints? — *A*. Yes, sir.

Q. This blowing-off of the brick at the "T" was when you were using pressure? — *A*. Yes, sir: I think it was.

Q. What is the purpose of that "T"? — *A*. In case there is any trouble with the pipe, it can be examined.

Q. Have you made any arrangement for securing the top of this "T"? — *A*. I cannot explain that.

Interrupted by MR. HAMMOND.

Q. Are there a great many of them? — *A*. I think seven (7). In regard to the soup-pipe that went up on the hill, we consulted with a number of different men, and showed them the pipe; they thought it would be perfectly safe and secure; and on their advice we decided to lay it in the ground, and after it had been laid and the pump used, in two (2)

[1] This consists of a series of wooden tanks, partially filled with porous material, through which the washings of the floor, &c., run by gravitation, in order to be "filtered," and then are pumped up to the cask, from which the flow to Alewife Brook is by gravity.

days they discovered a leak, and to my knowledge I don't know of any other that occurred. We had the leak repaired, and then used the pipe with the pump four (4) or five (5) days for the soup and drainage, until we had repaired, and could use, the other one [the drain]. We then took the soup-pipe up, and placed it on the trestle-work.

MR. WARREN *resumes questioning.*

Q. How deep are your wells? — *A.* About twenty-five (25) or thirty (30) feet.

Q. How many of them? — *A.* Eight (8).

Q. Where are they? — *A.* Between the engine-house [E] and the conduit. I think there are two or three inside the engine-house.

Q. And they are wells from which you draw water? — *A.* Yes, sir.

Question by the BOARD.

Q. Driven wells? — *A.* Yes, sir.

Q. What size? — *A.* Two-inch tube.

MR. WARREN *resumes.*

Q. I will ask you if you have endeavored to get from the city of Cambridge, or its authorities, all aid you could in the construction of this work? — *A.* I have, sir.

Q. To what extent have they been willing to protect the water of Fresh Pond by giving you advice in the matter? — *A.* Not in the least, except in case there was any danger of fire, as they kept constant watch over us. I have been free to ask their advice, and said to Mr. Carter and Mr. Hammond the day after we got our permit, that we should be pleased to receive suggestions from them, at any time.

Q. They gave you good advice? — *A.* They gave me some very good advice in regard to going there. I replied, we shouldn't go without we got the advice of good business men, in whom we could place implicit confidence, and if there was any thing they thought they could offer in improvement we should receive their advice.

Q. I suppose, as far as the management of the slaughter-house business goes, Mr. Boynton knows more than you? — *A.* Yes, sir.

Q. Is he any thing more than your agent? — *A.* No, sir.

Q. Did you see the leaks on the railroad? — *A.* Yes, sir.

Q. How extensive were they? — *A.* Well, I should think there were three (3) or four (4), and covered a surface one-half (½) as large as this table; others were not more than two (2) feet wide.

Q. Did they show on the surface before the earth was taken up? — *A.* Some of them did before the pipe was dug at all.

Q. Did you know whether the pipe was stopped up anywhere? — *A.* I don't know that it was.

Q. One of the witnesses yesterday spoke of seeing something come from the upper sash of one of the windows, in the lower story of the hog-house; do you know what that was? — *A.* Yes, sir.

Q. What was it? — *A.* One of those accidents that happen: a man left the water running in the hog-house, and a little water ran down

on the outside; I should think there could have been but a small quantity.

Q. Are those floors calked? — *A.* They are filled with pitch.

Q. All the floors in the building? — *A.* They are all, except the cellar floor in the main building: we didn't consider that necessary, as we had a cemented floor underneath.

Q. Is there any basement under the hog-house? — *A.* There is a basement that is used for the filter.

Q. That filter is in the basement of the hog-house? — *A.* Yes, sir.

Q. And that is laid on the cement? — *A.* The floors?

Q. Yes. — *A.* No, sir: I think it is laid in pitch; I think the joints are all filled with pitch.

Questions by the BOARD.

Q. There is no bituminous matter? — *A.* No, sir.

Q. It is a wooden floor, pitch joints, coal-tar, &c.? — *A.* Yes, sir.

MR. WARREN *resumes examination.*

Q. The filters are water-tight? — *A.* Yes, sir.

Q. Water carried into them from above, and carried back by the pump? — *A.* Yes, sir.

Q. How soon after these leaks occurred, so far as you can tell, did you know about them? — *A.* I was there every day: they couldn't have leaked longer than a day or a few hours.

Q. Did you proceed immediately to repair them? — *A.* We did.

Q. You have no doubt that they are all satisfactorily repaired? — *A.* I can say they are perfect now; for I have been over, nearly every day since they were completed.

Questions by the BOARD.

Q. Under this main floor, the cement was three (3) or four (4) inches thick? — *A.* Yes, sir.

Q. How far does that extend, — the cement, — up to the wall? — *A.* Yes, sir; brought up on to the side of the wall: I understand it so, that is the way orders were given.

Q. How far up? — *A.* I think three (3) or four (4) inches.

Q. All around? — *A.* Yes, sir.

Q. Inclined to the centre? — *A.* Yes, sir.

Q. Towards the drain you spoke of? — *A.* Yes, sir.

Q. And the drain leads to the filter-basin? — *A.* Yes, sir.

Q. Which communicates with — ? — *A.* The drain to Alewife Brook.

Cross-examination by MR. HAMMOND.

Q. You say that you saw these leaks in the drain; what did you see? — *A.* Colored water there, somewhat bloody.

Q. Did it smell badly? — *A.* I don't think I noticed that it did.

Q. You had just been in the slaughter-house? — *A.* No, sir; just got off the cars.

Q. Was that the water that had run through your filter? — *A.* I don't know, certain, how that was.

Q. Don't you represent to this Board that you put nothing into this drain but what goes through the filter? — *A.* I think it did.

Q. Is that filter a good one? — *A.* I think so: I don't think you could have a filter that would take out all the matter.

Q. Then you didn't have any filter there that would take all the matter? — *A.* I know that the first one —

Interrupted by MR. HAMMOND.

Q. You say that this stuff runs through the filter that you used? — *A.* I am not positive.

Q. You don't intend to put any thing in your drain but what goes through the filter? — *A.* No, sir,

Q. You think that matter must have been through the filter? — *A.* I think it must have, — yes, sir.

Q. What have you to say about that? — *A.* I think that was the time of the leak, and we could not help it.

Q. Did you hear Mr. Boynton say, when he was out there, that you didn't propose to put any thing into that drain which would be detrimental to the water? — *A.* I don't remember.

Q. That was your idea of it? — *A.* Yes, sir.

Q. You don't now mean to put any thing into that drain except what has been filtered? — *A.* No, sir.

Q. Why did you start before you were ready? — *A.* I admitted that we made a mistake in starting too soon.

Q. Why did you start? — *A.* We thought we had made calculations for all necessary delays.

Q. Was not it the price of pork that made you start so quickly? — *A.* No, sir: it was no more or less than as a business transaction. Whenever we were ready, we wanted to start business; we ordered our hogs, when we thought we should be ready for them.

Q. You went into that slaughter-house before you had every thing fixed? — *A.* I supposed it would be of no injury to anybody.

Q. You admit it was a mistake? — *A.* Well, yes, sir.

Q. Do you remember Mr. Boynton's saying out at Cambridge, when asked, "that he only proposed to put into the drain water from the ice-house and from the pickles and from the machinery"? — *A.* I think so.

Q. Now, did you make a statement, or did Mr. Boynton, at that hearing on the 3d of August, make a statement, that you "intended to have an open ditch or a closed drain"? — *A.* No, sir: I don't know as we had fully decided on that; we were going to do it in the most secure way possible. We thought of having an open drain first; and then that was objected to, and then the box drain was complained of, and then we decided on a metal drain.

Q. When did you decide on the metal drain? — *A.* Two months ago.

Q. You put that in there, and it was not right? — *A.* Yes, sir.

Q. Then you undertook to fix the joints up by putting bricks in? — *A.* Yes, sir.

Q. Whose suggestion was that? — *A.* The masons'.

Q. That didn't secure it? — *A.* That pipe wasn't laid for a pressure pipe.

Q Your first idea was not to have a pressure pipe? — *A.* After we had got it laid, we found that the pressure of the water back was so great —

Interrupted by COUNSEL.

Q. You were bound to get clear of the stuff, pressure or no pressure, weren't you? You put in a "T" under the advice of mason? — *A.* Yes, sir.

Q. You put in bricks, and they blew out? — *A.* There was one.

Q. And finally that didn't work, putting brick around the joints; and finally you relaid the whole pipe? — *A.* We have, sir.

Q. What is there in the joints now? — *A.* Oakum and lead.

Q. Under whose advice? — *A.* Water-pipe layers'.

Q. Now, is your idea to put the drainage through the pipe under steam pressure? — *A.* No, sir. We consider it perfectly safe to do so, however.

Q. You mean to, if necessary? — *A.* Yes, sir.

Q. You mean, if necessary, to put in the same stuff you put in before? — *A.* We don't see any reason why it is necessary.

Q. Am I to understand that that bloody matter went through your filter, or didn't go through the filter? how was it? — *A.* I think it did go through the filter.

Q. Who advised the filters? — *A.* I don't know who advised that filter.

Q. And that is the way it worked? — *A.* Since then, we have got a new filter — [Interrupted.]

Q. Well, why did you change the filter? — *A.* By recommendation of some persons.

Q. Why wasn't the first satisfactory? — *A.* We didn't think so.

Q. Why? — *A.* Because it was not as good as there is.

Q. As a matter of fact, wasn't that stuff which was found upon the ground, — was not that a fair sample of the way that it was filtering water? — *A.* I can't say that it was.

Q. Was not that the reason you testified? — *A.* I thought it was not doing as well as a filter ought to.

Q. You thought from the appearance of the liquid? — *A.* Yes, sir.

Q. How long did you use that filter before you changed? — *A.* I think it was some ten (10) days or a fortnight.

Q. And in that way this substance went down regularly? — *A.* Some days; didn't always.

Q. On account of the fact that that filter didn't seem to work, you put in another? — *A.* The same filter, but different material in it.

Q. How long have you been using that? — *A.* Two (2) or three (3) days.

Q. Up to the present time, you have used the others? — *A.* I should say about three (3) or four (4) or five (5) days since we put in new.

By the Board.

Q. What do vou use for filtering now? — *A.* Coke.

Question by Mr. Hammond.

Q. So much for drain-pipe; let us pass to the other point. Your first idea was to get clear of the soup somehow; didn't you apply to a chemist to see if you couldn't have it chemically treated in such a way as to be unobjectionable? — *A.* I think that was a question we asked Professor Sharples.

Q. And he said it couldn't be done? — *A.* He said it wouldn't be practical.

Q. The idea was suggested of running the soup into the muck-bed, wasn't it? — *A.* It was a plan to carry it in the pipe over in this direction [easterly, pointing to the map].

Q. Why didn't you carry it there? — *A.* Because we thought that the other location was very much better.

Q. At the hearing before the Belmont people, you represented that that pipe was going in this direction [pointing to map], and your muck-heap was here? — *A.* Yes, sir: that was what we proposed to do at that time.

Q. What rights have you where the muck-heaps are now? — *A.* A lease of two years.

Q. Whom did you get it from? — *A.* Owners of the estate.

Q. Who are they? — *A.* I don't know what the names of the people are.

Q. You can't remember? — *A.* I can't.

Q. Any part of the name? — *A.* No, sir, I can't: I can tell you where the man is; he is in a piano-factory, on Washington Street.

Q. After that two years expires, do you know where you can get a place for the muck-heap? it depends on what arrangements can be made, don't it? — *A.* Yes, sir: we got permission to continue if there was no objection whatever. We had a permit to place it here [to the east].

Q. Who was that party? — *A.* Mr. Heywood.

Q. You represented to the Belmont selectmen that this pipe that went to the muck-heap was not to be a pressure-pipe? — *A.* I thought it would carry the soup, etc., out.

Q. And you thought that there would be fall enough from the second story of this building to carry it off? — *A.* Yes, sir, I thought so.

Q. Instead of that, you run it over the conduit in that direction? [pointing to the map, toward S.] — *A.* Yes, sir.

Q. You run it as a pressure-pipe? — *A.* Yes, sir.

Q. Why did you make up your mind? — *A.* We found we couldn't carry it up there without pressure.

Q. You put it down under ground at first two (2) feet? — *A.* More than that; three (3) feet.

Q. Pretty near water-level? — *A.* I don't know about that.

Q. You should think three (3) feet under ground? — *A.* Yes, sir.

Q. It was laid so low there was water in the trench? — *A.* Yes, sir: in some parts, where it was taken up.

Q. How have you it now? — *A*. On trestle-work.

Q. High up? — *A*. Yes, sir.

Q. How high? — *A*. About twelve (12) feet.

Q. How have you got it protected from the frost? — *A*. None yet.

Q. It is flange-pipe, and tight? — *A*. Yes, sir.

Q. It will stand pressure? — *A*. I think so.

Q. Whose advice have you had about it? — *A*. The engineer that laid the pipe; he is acting as our engineer at the building, and pipe-laying has been his business.

Q. You don't know how you are going to protect it from the frost? — *A*. We think all the protection needed is a box filled with charcoal.

Q. You are going to box it? — *A*. We propose to do it.

Q. Got your plans ready? — *A*. We have them, when we are ready.

Q. The same man that laid the soup-pipes was the man that advised you in this matter? — *A*. I think so: I don't know as we have any reason to question that now.

Q. How do you get along with your muck-beds in cold weather? — *A*. We don't anticipate any trouble.

Q. You think you are going to get that soup into the ground, frost or no frost? — *A*. I think not.

Q. Have you calculated on packing the soup-pipe, if the climate should render it necessary? — *A*. Yes, sir: but, if you take notice, there is a sufficient fall so that there is no water going to stand in the pipe at all: where it strikes the hill at the top, it runs down into the muck-bed, and the rest back into the house.

Q. You yourself have never been in this muck business before? — *A*. No. sir.

Q. It is a matter of experiment, so far as you are concerned? — *A*. Yes, sir: that is why I went to scientific men for advice.

Q. Did you find a scientific man that ever run one of those muck-heaps? — *A*. No, sir.

Q. Did you ever see one run before? — *A*. No, sir.

Q. You went in there, and kept, for some time, a portion of the results of the slaughtering in your establishment? — *A*. Yes, sir.

Q. How long did you keep the offal in your establishment? — *A*. Perhaps four (4) or five (5) days before we got a dryer.

Q. And you had some carted off? — *A*. Yes, sir; some of it.

Q. You say you spent thirty thousand dollars ($30,000). How? — *A*. In the building.

Q. What has the building cost you? — *A*. I told you I could not give the exact figures, but calculated thirty-two thousand to thirty-four thousand dollars ($34,000).

Q. Who is associated with you in your business? — *A*. I don't know but I shall appeal to my attorney to find out what the inquiry means.

Q. Yourself and two brothers? — *A*. Yes, sir.

Q. You mean to say that yourself and brothers paid thirty-two thousand dollars ($32,000)? — *A*. Yes, sir; every cent of that has been paid.

Q. Have you received any assistance from anybody else? — *A*. No, sir.

Q. Any money? — *A.* Do you mean to say — [Interrupted.]

Q. Any one else interested in that project? — *A.* Not in the least.

Q. Have you bought the land? — *A.* Yes, sir.

Q. Since the hearing at Belmont? — *A.* Yes, sir.

Q. How much land? — *A.* Ten (10) acres.

Q. Do you know whether there is any thing shown of it on the plan? — *A.* I should think that was pretty near it [pointing to map]. There is a strip of a hundred feet between us and the street.

Q. I want to ask you in a general way, whether, if this slaughter-house should be enjoined, Mr. Heywood would be at all interested? — *A.* Not in the least. No man has any claim whatever to these premises; no man any interest in the matter; we have never given any notes yet either.

Q. How much water do you take from these wells? — *A.* I am not able to give the figures.

Q. It is ample? — *A.* Yes, sir.

Q. Water circulates freely? — *A.* Sufficient for the premises.

Q. How much do you use? — *A.* I haven't got the figures: I don't know.

Q. There is one further line of inquiry that I will speak of. You spoke of a conversation you had with Mr. Carter himself, and left before it was through? — *A.* Yes, sir.

Q. It was in Boston, near Tremont Street? — *A.* Yes, sir.

Q. The day after, or the very day, you received notice that the selectmen of Belmont had given you permission? — *A.* Yes, sir.

Q. You say Mr. Carter gave you some good advice. Did Mr. Carter say to you that he should advise you to look over this matter very carefully, because the city of Cambridge would probably pursue this thing; they would do all they could to remove the slaughter-house from the pond? — *A.* As near as I can remember, I think he treated it a little stronger than that. He said, "You had better not go there; you had better consult the State Board of Health;" and he also said, "We shall follow you as far as the law will allow."

Q. You got the idea that the city of Cambridge felt as if it was their duty to act against you as much as they could? — *A.* It seemed to me as if it was more for a will than a cause. I requested to know if we could give guaranties, whether it would make any difference.

Q. You understood that he was president of the Water Board? — *A.* Yes, sir.

Q. Didn't he say he thought it would be a good plan for you to see your counsel? — *A.* Yes, sir.

Q. Didn't he say you had better see the State Board of Health? — *A.* Yes; but he was too late, as I was on my way then from the State House.

Q. Had been there to see them. How far along was your building at that time? — *A.* I can't say. I think we had got the foundation walls up and the contracts all completed, and the principal part of the frame-work done.

Q. Your first movement in regard to this matter was to get somebody to survey the land? — *A.* Yes, sir.

Q. Did you consult a single man in Cambridge in reference to the matter? — *A.* I don't think I did.

Q. Did you inquire of the people of Cambridge whether there would be any objection to it? — *A.* I don't think I did.

Q. Did you know that Cambridge was drawing water from Fresh Pond? — *A.* Yes, sir.

Q. Were you not told by Mr. Kendall that the people would howl about it, and you had better look out? — *A.* Not then.

Q. Did you consult the people of Belmont? — *A.* We did, through the whole neighborhood.

Q. Why? — *A.* Because we thought they were the only parties interested.

Q. It didn't occur to you that Cambridge was interested at all? — *A.* Not at that time.

Q. When did it? — *A.* Not until I had got word that the Tudor Ice Company and the city of Cambridge were making objections.

Q. You knew Mr. Barker lived very near? — *A.* I don't know.

Q. Did you yourself go and see the people of Belmont? — *A.* No, sir.

PROFESSOR NICHOLS *called.* — *Direct Examination by* MR. WARREN.

Q. You have examined these premises? — *A.* Yes, sir.

Q. When did you first visit them? — *A.* Couldn't say, not the exact date: it was a short time after the Belmont hearing; the foundations were laid, and I think the framework had gone up.

Q. At whose request did you go out there? — *A.* Mr. Boynton's, or that is, through Mr. Elliot, who came to me on the part of Mr. Boynton and Mr. Niles. Mr. Elliot was formerly city engineer of Somerville.

Q. You may state the condition in which you found things there. — *A.* I don't know as there is any thing to state, the building was not far enough along: my attention was then called particularly to the general location. I was shown what the plans were, with reference to the building, and also with reference to the disposal of the various waste materials.

Q. Did you go out there often after that? — *A.* Once or twice since then, but not recently. The question asked me particularly at that time was whether, in my opinion, with that location and with the plans for carrying on the work which were detailed to me, there was any reasonable apprehension that Fresh Pond would be affected by these works; and the opinion that I expressed then, and I hold now, is, that on that location, with the plan proposed, the business could be carried on without affecting the water at Fresh Pond.

Q. Did you pass, or have, any opinion about the attempted utilization of the soup by means of muck-beds? — *A.* Yes, sir: I inquired about the means of disposal of the soup, and was informed that there would be a probable market for a considerable portion of it; it could be carried off, and delivered to farmers, &c., and in that way a large portion of it disposed of; and of a plan for disposing of what balance there might be. I think it would be possible to treat it in that way. I have made no examination of this particular muck, for it hadn't been

excavated. I know what muck is, in general, and, if properly treated, the soup could be covered over by muck before it would become offensive ; my opinion was that the works could begin without finally deciding in which way it should be treated. There could be no possible danger in handling the soup that way ; and they expressed a purpose, if found necessary, to conduct the mixing of the muck on a cement-lined basin: I don't know that there would be now any occasion for that at all: it would depend on the amount of the muck at disposal, and the dryness of it. The soup would soak into the muck, if it is properly dried, and muck, according to its dryness, will absorb more or less, and it can be covered over at once; in fact, I think a limited amount might be disposed of with simply the soil that lies where the muck-beds are built; but wouldn't care to recommend it as a plan, without having any particular means to absorb it at hand.

Q. Taking the area over which it could be spread, and the distance from the pond on this side, and Wellington Brook on the other, you mean to say it would be some time before any effect would be produced? — *A.* I don't think any effect at all would be produced with small amounts.

Q. Can you give any statement that you will be willing to make, in regard to the absorptive powers of muck? — *A.* I couldn't state exactly as to how much that muck would probably absorb of the soup: my feeling is, that the muck, if reasonably dry, could be made to absorb a certain quantity of soup, and, after it had dried somewhat, could be used to absorb an additional quantity, and so on, until a considerable portion had been put in. I think so much soup could be put into the muck, as to make it worth something as a fertilizing material.

Q. Supposing trenches were dug in the muck-heap, so as to prevent water from running off? — *A.* I think that the soup is so hot that it would thaw the muck enough to be absorbed by it; or, if it flowed off, it would freeze, and could be taken care of very easily.

Q. I suppose that the animal matter which produces impurities in the water is much more dangerous, in the form of human excrement than any thing else? — *A.* It is so regarded.

Q. Have you made any analysis of the Fresh Pond water? — *A.* I have, sir.

Q. What are the impurities, so far as they can be developed by analysis? what is the nature of them? what the character? — *A.* At the present time, there is not enough animal matter in the water to be recognized as such; the waters, so far as chemical examinations show, are sufficiently pure, as far as that goes.

Question by the BOARD.

Q. How long since you examined it? — *A.* During the present year. I should say, that to be distinguished by chemical tests, the amount of animal matter, as such, must be what a chemist would call large; a considerable quantity might be disseminated through the water, without being recognized by chemical tests unless you knew it was going to be put in before you compared the water.

Questions by MR. WARREN *resumed.*

Q. I want to get at this, whether in view of a recognized fact, that a large part of the surface which is drained into Fresh Pond has been cultivated for perhaps fifty (50) or a hundred (100) years, and for a great many years has been cultivated very highly, and manured richly with night-soil and other animal manure, — whether there could be any condition less favorable to the purity of the water of Fresh Pond than now exists; whether any worse treatment of the soil could be made? — *A.* I don't think you could treat the shores of the pond worse than to manure them with night-soil; of course a direct flow would be worse for the pond.

Q. I suppose that this pond is fed by springs, and that the sources of the supply are from higher soil around it: does not the water have as hard a chance to be pure as it could have? — *A.* I don't want to say that. It might be worse than it is, I think.

Q. In what space would water, which had been polluted with night-soil, become relieved of impurities by percolation through gravelly and sandy soil? — *A.* No rule could be laid down: you couldn't fix an exact limit through which the water, having a certain grade of impurity, would have to flow before it became purified.

Q. I have read from Professor Sharples's report to the joint special committee at the City Hall, under date of Dec. 18, 1876, in which he refers to a determination made by Mr. Nichols upon the water of Fresh Pond, and I begin with the concluding sentence: [reads] "Numerous determinations made by Professor Nichols," whether or not this fact is established, that, if time enough be given, water will purify of itself? — *A.* Well, sir, there is a great difference of opinion about that.

Q. Your experiments related to running water? — *A.* That conclusion is something I never drew myself, with reference to water running in pipes: in the first place, I never made any experiments to test this particular point at all; there is no question but a large amount of impurity is destroyed by natural processes; but I believe in aiming at the greatest possible purity, and if I felt that these parties were going to run any thing objectionable into Fresh Pond, I should oppose it. With the plans and proposals they submitted to me, it didn't seem to me that they were going to put any thing into Fresh Pond to do any damage; that is my opinion, based on the statement made by those gentlemen. I don't see any reason why there should be any thing sent into Fresh Pond that would injure the water.

Q. I don't know whether you have had any familiarity with the process of taking care of offal? — *A.* Yes, sir, the drying.

Q. I suppose, if that process is properly carried on, there is no necessary annoyance to anybody outside of the building? — *A.* Might be occasionally, but not regularly. There is no reason why the drying should not be conducted so that all the offensive gases would pass off under the boilers and fires.

Q. Have you seen the building? — *A.* No, sir.

Q. Your judgment depends upon your seeing the plans? — *A.* I don't

know how it is now; I have seen a portion of the building: the construction was essentially finished of the hog-house, of the engine-house, and of that portion of the building opposite the hog-house and nearest the engine-house: that was constructed the last time I was out.

Q. You have seen substantially all the ice-boxes, and soaking (or cleansing) room? — *A.* I should say also, that the floor of the cellar was not boarded: they had cemented it, and a drain laid, and they were flooring at the time I was there.

Q. Is there any danger of any thing getting into the soil through that floor: the cement? — *A.* No, sir.

Q. If these drains worked well, the soil would be protected? — *A.* Yes, sir: every thing can be washed into the centre drain, which is really as impervious as it can be. I should say it was practically so, and the amount that would soak through would be practically nothing.

Q. Did you recommend any change in the filter-basin? — *A.* Yes, sir.

Q. What was it? — *A.* The change that I recommended was to make experiments on the best way of handling it. For immediate purposes, I didn't think the material in them proper or sufficient, and I suggested coke, which I thought would be better.

Q. Those filter-basins must from time to time be cleared out, and the material changed? — *A.* Yes.

Q. At the time of changing from one material to another, would you think that the material taken out might be necessarily a little offensive? — *A.* Yes, sir: I think so. Under the best of circumstances, I don't think you could avoid some odor in clearing it out, and in changing material.

Q. They were changing material then, were they? — *A.* Certainly. There had been an accident, as I understood.

Question by the Board.

Q. How often is it necessary to clean them? — *A.* As often as once a month.

Questions by Mr. Warren.

Q. You understood there had been an accident at that time, and that was what made the material in its condition? — *A.* I so understood, that there had been an accident at that time, and that was what made the material in its condition; yes, sir.

Q. So far as the arrangements for rendering and drying were concerned, did you see any thing to object to? — *A.* No, sir: I didn't make any particular objection.

Q. In connection with underground currents of water, if you found water at this point [pointing to map] standing at a certain level, and then followed all through the swamp here to the brook, and took levels on the surface water, and found the level constantly becoming lower, could you draw any inference as to the course of the underground water? — *A.* The water is very likely to divide by beds of clay; and I should say there probably would be variations in different parts, but, with a continual descent on the points taken, I should think it would give very near the water surface, or what might be called that. It

would not be likely that there would be a series of clay pockets, in which the water stood.

Q. You went on to that hill, didn't you? Can you, from surveys of that land, have any opinion as to what the water course would be? — *A.* No, sir: but I should have some hesitation in forming any opinion, any way, on that hill, because, from the excavations made, it is easy to see a clay packed in one place, but when the pipe was being put down at the corner of the engine-house they struck clay at different depths, about nine (9) or ten (10) feet: that is the information which I obtained from the man who was driving the pipes; the clay seemed to lie irregularly, and I thought it was from the clay from the hill. I should suppose from the lay of the land, that the water-table was continuous until you got to some out-crop of clay, but here I suppose the clay would be deeper, towards the pond; but at these points, it seemed that just there, the clay was reached sooner than it was ten (10) feet away.

Question by the BOARD.

Q. The clay-bank included the whole space, I suppose, on which the building was erected? — *A.* I don't know, sir.

Question by MR. WARREN.

Q. These wells were sunk lower than the bottom of the culvert? — *A.* They go through the clay: the water is taken from beneath the clay.

By the BOARD.

Q. What wells? — *A.* Wells for this establishment. Why I knew about the wells, I suggested to the proprietors, that they should keep a check on this thing, themselves, they shouldn't rely on the Cambridge water-works for the discovery of a leak; and they proposed to have a systematic examination, and, long before any thing did get to the ground to injure it, they would discover it first. If one was making a continual examination right along, it would be very evident.

Q. How deep is the clay here? — *A.* I only know that they struck clay at nine (9) to ten (10) or twelve (12) feet.

Q. They went through the clay to get their water? — *A.* Yes, sir.

Q. How deep was the clay? — *A.* That I don't remember; but they found it in every place they drove.

By MR. HAMMOND.

Q. If I understand you, you think that if any thing comes from that slaughter-house, and finally into the pond, you don't think it would be a good place for a slaughter-house? — *A.* Yes, sir: if any thing goes from the slaughter-house into the pond.

Q. Directly or indirectly? — *A.* Yes, sir.

Q. Why? — *A.* Because I think the water supply should be protected from all contamination. I don't mean to say if any thing came from there it would do anybody any harm.

Q. I want to know why, as a professional man, you think nothing from that slaughter-house would go into Fresh Pond? — *A.* My opinion

is, that there are three (3) things to be looked at: the building itself, and I think there is no difficulty in protecting that, so it won't leak; then the soup, and I think there is no difficulty in looking after that; then —

Questions by MR. WARREN.

Q. I understand you to say that you thought, if any thing went into the pond, you should say the slaughter-house ought not to be there? — *A.* I shall qualify that by saying, that if the condition of the works were such that there is a continuous discharge, either directly or indirectly, from the slaughter-house, I shouldn't think it ought to be there.

Q. You think it would be a good place to put the slaughter-house, if once in two or three weeks they emptied in a few barrels of refuse? — *A.* No, sir: I don't think they had better have this slaughter-house there in that case.

Q. Haven't you, in your various articles on the subject, insisted that the source of the water-supply should be as free as possible from contamination? — *A.* Yes, sir.

Q. Haven't you urged that in your official communications? — *A.* Yes, sir, as far as is practicable.

Q. "On the ground that water may be so impure as to be hurtful to the human system, although there is no method by which it may be discovered"? [reading frcm book.] — *A.* Yes, sir.

Q. And watch it as carefully as you may? — *A.* Yes, sir. I believe that perfect purity should be the aim.

Q. And do you believe, if this slaughter-house should be carelessly conducted, that there would be danger of something getting from it into the pond? — *A.* I think that this slaughter-house ought to be under supervision, and that, as I have stated, any establishment of this kind ought to be under supervision.

Q. Haven't you in your communications distinguished buildings into classes, and haven't you classed slaughtering-houses as a dangerous class of buildings? — *A.* I have no doubt I have, and should object to the establishment of a slaughter-house with drainage into a pond.

Q. Or you would object to a slaughter-house where there was a possibility of contamination? — *A.* Within reasonable limits. I shouldn't want to say that there could be no slaughter-house established in any part of the entire drainage area, provided proper care should be taken in regard to offensive material.

Q. We refer to an article in the Fifth Annual Report of the State Board of Health, p. 63 [reading article], "On present condition, &c." You prepared that article? — *A.* I did.

Q. There is a paragraph in this article where you speak — I will read it to you. [Reads.] "Different in character, however, is the excremental," &c. In this case, is not it a simple question of whether that is a proper place, in your judgment, to try these various experiments? Would you concede that slaughter-houses are particularly objectionable, and that any refuse from the slaughter-house should be kept from all

sources of water-supply? Now, acting as a public officer, would you say that, with that view of the matter, a slaughter-house should be allowed to be established on the borders of that pond?

Objection.

This question was objected to by Mr. Warren, on the ground that it was a matter which the Board of Health were to pass judgment upon: he said that he shouldn't pretend to claim that a slaughter-house ought to be put where it would in any way contaminate water that we drink.

MR. HAMMOND *proceeds.*

Q. In the ninth (9th) Annual Report is an article by you on the filtration of water; and I understand you there to say substantially that filtration does not remove from the water the objectionable features of slaughter-house refuse? — *A.* No, sir: I know of no process of filtration which could be relied upon.

Q. Filtration wouldn't do any thing with matters in solution? — *A.* Not much; no, sir.

Q. And isn't it true that this characteristic exists in water, to injure the human system; and isn't it true that no filtration that we know of helps the matter any? Polluted water has the power to affect the human system by disease; and whatever gives it that power — isn't it true that filtration doesn't remove that impurity from the water? — *A.* I shouldn't rely upon it.

Q. If this earth here should be contaminated by organic matter, and the water should finally go into the pond in that direction, the fact that it goes two or three hundred feet, more or less, over gravel-beds, in your judgment, would that be sufficient to render it pure? — *A.* No, sir: I don't think so, although I don't hesitate to use Fresh-Pond water, even when I know there is night-soil in the neighborhood.

Q. You are familiar with the location of Fresh Pond: is not it true that as a rule we find, tending towards the pond suggested, the ground-water of the surrounding neighborhood? — *A.* Yes, sir.

Q. Unless, then, there are some beds of clay here to prevent, you would expect the ground-water of Fresh Pond to tend towards it, wouldn't you? — *A.* I am not sufficiently acquainted to say. I simply say that the tendency of the water might be to the pond naturally.

Q. But unless there was some barrier here like clay you would expect the ground-water would tend toward the pond? — *A.* Yes, sir.

Q. And then, of course, the more you suck out of the pond, the larger you would expect the circulation of the ground-water, or the flow? — *A.* I doubt whether the pumping of Fresh Pond would make much difference with the flow of the ground-water.

Q. You stick to every thing you have stated there in the books [reports of the State Board of Health], don't you? — *A.* Well, generally: there may have been some mistake, or statement which I would want to modify.

MONDAY, Dec. 28, 1878.

MR. GEORGE F. FULLER, *called.* — *Direct Examination by* MR. WARREN.

Q. Are you architect of this building? — *A.* Yes, sir.

Question by MR. HAMMOND.

Q. Did you superintend its construction? — *A.* Yes, sir.

MR. WARREN *resumes.*

Q. Now will you give a description of the building? — *A.* It is a wooden building heavily timbered and thoroughly braced; the floors have extra pains taken in the laying of them, the under floor being hemlock boards, and the upper floors hard pine, with the exception of the basement, and all thoroughly calked and run up with pitch; most of the floors have been calked three (3) "threads," as we call it; the floors are laid as tight as a ship's deck. The basement-floor has four to six inches of concrete, which goes up the side eight (8) or ten (10) inches along the basement walls; we made this concrete extra thick, and rich in cement, more than we should do in some floors; we don't depend on the wooden floor laid on the cement for any thing more than keeping the cement under it intact, and it is not tight. It is a hard pine floor, and is dowelled throughout. The upper floors throughout the buildings are fitted with an inclination, so as to be washed into the gutters prepared to receive the water; we took pains, on the sides of the floors, to have the plank turned up about four (4) inches on the side walls so as to get an inclination of four (4) inches, and it is fastened to the floor and calked all around; all the floors are the same. In the hog-house, where the live animals are kept, we laid a hemlock floor, in a similar way, and then a spruce floor calked; we had between the hemlock floor and the upper floor two thicknesses of tarred paper; and floor-sheathing paper was laid between the floors in the main building: they were fitted with bevelled plank.

Q. Practically state whether each one of those rooms is water-tight, except where an opportunity is given by the drain to run off? — *A.* They will hold water.

Q. Can any water escape from that building or either of those buildings, upon the ground, through the floor? — *A.* No, sir.

Q. What are the arrangements for the supply of water? — *A.* That was under the charge of the engineer who runs the boiler, and I don't know exactly: they have two (2) large iron tanks in the upper part of the building; I should judge they are eight (8) feet high, twelve (12) feet in diameter; they are all supplied by a force-pump with two-and-a-half inch pipe; I think that the source of the water is from those eight (8) wells; pipes are laid from these tanks all through the buildings; they have hose, in some, from four (4) to six (6) places on each floor; I have not counted them.

Q. About the strength of the timbering of the building with reference to its capacity for holding the weight? — *A.* It is amply strong, with *three-inch* and four-inch timbers, twelve (12) inches deep.

Q. What has the building for a foundation, with reference to its permanence? — *A.* It has an excellent foundation, of stone and brick, and gravel bottom, except in some places where they went down to hardpan of clay on the lower side.

Q. How far before they struck the clay there? — *A.* The foundation varied. In some places, the stone walls are six (6) or eight (8) feet high. Then we have six (6) feet of brickwork above that. These walls are laid with an air space, and including the air space are twenty inches thick, I believe.

Q. Do you know about the construction of the drains? — *A.* I have noticed them, yes, sir; with the exception of that drain by the railroad-track.

Q. I refer to the drains in the building, the construction of the main drain in the basement: do you know about that? — *A.* Yes, sir.

Q. How is that made? — *A.* That is laid in cement and concrete.

Question by the BOARD.

Q. How large is that drain? — *A.* Ten (10) inches inside, I think.

MR. WARREN *resumes.*

Q. Square drain? — *A.* Box-drain, about six hundred (600) feet long, lined with brick.

Q. Inside? — *A.* Yes, sir; on the bottom of it.

Q. Is there not, on the outside, a brick wall each side of it? — *A.* It comes right down lengthwise through the buildings, right in the middle, as near in the middle as it is possible for it to get, on account of the posts.

Question by the BOARD.

Q. Less than half of this floor is laid now; is it intended to lay the balance of it? — *A.* All the floor is laid in the building: what remains is the ice-house which is to be constructed in the same way.

MR. WARREN *resumes.*

Q. Now all drainage from the upper stories is carried off in closed pipes: how is it carried off finally? — *A.* Through iron pipes.

Q. Do these pipes come into this drain in the basement? — *A.* Yes; but not so as to discharge into it; they pass through the end of it to the cesspool.

Question by the BOARD.

Q. Where is the cesspool? — *A.* Outside, between the engine-house and the main building.

MR. WARREN *resumes.*

Q. In making the plans of this building you will say, and arranging for its construction you will say, whether you examined the best slaughter-houses of the kind that there are? — *A.* I visited several others, with the intention of incorporating the best ideas of those in use.

Cross-examination by MR. HAMMOND.

Q. You are an architect by profession? — *A.* Yes, sir.

Q. How long have you been so? — *A*. Very nearly twenty (20) years.

Q. Have you been in the habit of constructing slaughter-houses? — *A*. I have constructed several.

Q. Within what time? how many within the last five years? — *A*. I have made plans for two that have been annexed to the abattoir at Brighton.

Q. Did you build this like them? — *A*. Well, those were for slaughtering cattle. I think this is for hog-slaughtering: virtually the same ideas; this being the larger building is more heavily timbered.

Q. I don't understand about the drainage of these floors: every floor in the main building is built upon an incline towards the centre? — *A*. The upper story of the cooling department, that pitches of itself, that being the form of the main building, that dishes to the centre, this way; this portion of the floor out here is level; the floor under there dishes towards the centre.

Q. The upper floor upon which they slaughter has two (2) drains in it, one going one way, and the other the other: what goes in there is bloody? — *A*. No, sir; except a little when the animal is cut up.

Q. Where does that go? — *A*. It is washed through the pipe into the cesspool below.

Q. In the ground? — *A*. Yes, sir.

Q. Directly into that? — *A*. Yes, sir; I think so.

Q. What is your plan? — *A*. I think the drains are above the ground, on second thought.

Q. And you have no plans that show the drains? — *A*. No, sir.

Q. Can you tell me where the drainage from this room, where the slaughtering is, goes? — *A*. It goes through those filters.

Q. The hog-house floors are as tight as any of them? — *A*. Yes, sir.

Q. You heard Mr. Niles state how somebody left some water flowing there, and it flowed over? — *A*. Yes, sir; it flowed over those "cants" there.

Q. Were you there at the time the foundations were dug and laid? — *A*. Portions of them, yes, sir; was not there all the time.

Q. Can you tell there on the plan, where the clay was struck? — *A*. At different points along the sides [pointing to map].

Q. Then did they strike it a little on this [south] side? — *A*. Yes, sir.

Q. How far along did they go on, through one of these sides, before they got out of the clay? — *A*. I couldn't say exactly, but I judge along two-thirds of the way up to the engine-house.

Q. Clay kept growing deeper and deeper? — *A*. Yes, sir; this way [pointing to map].

Q. Towards the brook? — *A*. No, sir; this way [westerly, pointing again]. There we struck into a gravel-bank.

Q. When you ran out of the clay there, was it deeper than when you ran out of the clay here [at the easterly end]? — *A*. That varies: those clay banks seemed to be in pockets.

Q. Didn't seem to be the foundation of things there, — mere accident, was it? — *A*. In some places the clay was deeper than in others.

By the BOARD.

Q. Please tell us about the basement floor: is it water-tight? — *A.* Yes, sir: it is laid as carefully as the others.

Q. Is it also laid up on the sides? — *A.* Yes, sir.

Q. Just the same as all the rest of the building, practically tight? — *A.* Yes, sir; unless water flows over the top [of the cement on the sides].

Q. How high up the sides? — *A.* About four inches above the floor.

MR. STEARNS *called.* — *Direct Examination by* MR. WARREN.

Q. Your name is Marshall M. Stearns? Did you lay the brick portions of the foundations of this building? — *A.* I did; yes, sir.

Q. Did you also lay the drains? that is, did you lay whatever drains required brickwork? — *A.* Yes, sir.

Q. Now, will you describe the laying of these drains, and will you state where you laid them, and what their construction was? — *A.* There was a cesspool built in the middle, between the engine-house and the main building (square cesspool). I should think it was six feet long, three feet wide, and about five (5) or six (6) feet deep. This is constructed at the middle of the building, or as near the middle of the building as we could get it running from the north to the south end. Right straight through the centre, with a pitch of seven (7) inches, and going across the building, laid with a course of brick, — that is the idea of the drain.

Q. How long? — *A.* Two hundred and fifteen (215) feet, outside measurement, four (4) feet to come out of that: this is the plan [shows plan to Board]; that is brick and cement.

Q. This cesspool is made of what? — *A.* Hard bricks, as good as we could get, and cement; plastered inside with Portland cement, so as to make it strictly tight, with eight-inch walls, and with the bottom three (3) to four (4) feet below the bottom of the drain.

Q. Where does the water from that cesspool run? — *A.* It runs through a six (6) inch iron pipe into the receiver [filter].

By the BOARD.

Q. Are the drains from that cesspool from the top, or bottom? — *A.* The drain that enters and the one that goes from the cesspool are right on a level.

By MR. HAMMOND.

Q. What is the capacity of that cesspool? — *A.* Couldn't say.

Q. That drain which you laid in the basement takes out the washing? — *A.* Only what gathers from the lower floor.

Q. Whatever is washed from it, and from any of the upper floors? — *A.* The upper floors have their own pipes.

Q. Do you know about the construction of those pipes that take water from the upper floors? — *A.* I don't know, sir.

Q. Now, is there any other work that you did there? — *A.* I have done all the mason-work, and laid those pipes the first time they were laid.

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Q. The one [soup-pipe] that has since been taken up?—*A*. Yes, sir.

Q. You didn't lay the pipe up on the hill?—*A*. Yes, sir.

Q. The first one?—*A*. Yes, sir.

Q. Did you make the joints?—*A*. I had a man that followed along as I put them in; I had a man that had worked in the drain business for a number of years, that did the work.

Q. Are there any other drains that you have laid at present in use?—*A*. No, sir.

By the BOARD.

Q. You laid the pipe from the cesspool to the hog-house?—*A*. No, sir, I didn't: the engineer that they had did that, I think.

By MR. WARREN.

Q. Were you present at the laying of the present drain that runs down the railroad?—*A*. Yes, sir.

Q. How were those joints made?—*A*. The joints were packed with oakum, and leaded.

Q. Did you see the trench in which the foundation was laid, before the stonework was put in?—*A*. I saw most of it.

Q. Mr. Fuller says there was clay in some places; how did they go to find it?—*A*. It was hardly a clay; it was a quicksand and clay mixed together. It was here in the centre [pointing to map]. At this point here [south-west corner of the slaughter-house] it run entirely out; nothing but quicksand. The deepest place is in the middle.

By the BOARD.

Q. How deep is the clay?—*A*. I should say that they went down five (5) or six (6) feet on this side next to the track, in one place, because we got water there to make the mortar.

Q. Below the basement floor?—*A*. Yes, sir.

Q. Didn't get any here [south-west corner] at all?—*A*. No, sir.

Q. Don't know how deep it is?—*A*. There is not any there; we didn't go deep enough to get it, because we got good gravel; this was the hill on this side. They dug it away when they put the building there, and it was carried over in here to make this railroad-track.

Cross-examination by MR. HAMMOND.

Q. You find a clay soil mixed with quicksand here,[1] and none here, and none there, and none there?—*A*. No, sir.

Q. Any here? [north-west corner.]—*A*. Very little; they had to dig out very little mud right at that corner.

Q. Then, as I understand you, as they went in this direction [south-west], it gradually grew less until there was none?—*A*. Yes, sir.

Q. Did they dig as deep to lay the stone on the rear side of the buildings as they did on the front side?—*A*. Yes, sir; deeper.

Q. How much difference?—*A*. About twenty (20) inches.

[1] At the centre of the building, and none at three corners.

Q. At that corner there was a little clay, and as they worked this way [south] they worked out of it? — *A.* Yes, sir.

Q. Any clay in digging for the cesspool? — *A.* No, sir.

Q. Now, take the engine-house: how deep are the foundations of that? Are they as deep as the foundations of the main buildings? — *A.* Yes, sir; deeper.

Q. Any clay there? — *A.* No, sir.

Q. Did you go deeper for the chimney than you did for the buildings? — *A.* Yes, sir.

Q. How deep? — *A.* About eighteen (18) or twenty (20) inches.

Q. Deeper than you did for the foundations? — *A.* Yes, sir.

Q. Did you strike clay? — *A.* No, sir.

Q. You say that there is a cesspool in the middle of the building right out of doors there? — *A.* No, sir.

Q. Where? — *A.* Under a shed between the buildings [slaughter-house and engine-house].

Q. Under the building, between the slaughter-house and engine-house? — *A.* Yes, sir.

Q. What pipes run into that cesspool? — *A.* A six-inch iron pipe connected with the wooden drain, about four (4) feet from here.

Q. Where does it strike the wooden drain? — *A.* At the end of the building.

Q. On what floor? — *A.* On the lower floor, in the basement.

Q. And one end of that wooden drain connects with that iron pipe: where does the other end connect? — *A.* The pipe runs down into the wooden drain, along inside of it, and so into the cesspool.

Q. The wooden drain runs the whole length of the building? — *A.* Yes, sir.

Q. Does it connect with any thing at the further end? — *A.* With the side of the building.

Q. Any thing else? — No, sir.

Q. That is on the lower floor. What goes into that drain? — *A.* The water that collects on the lower floor, and what goes down from the pipes as they go into the cesspool.

Q. What pipe inside the building is connected with this wooden drain? — *A.* I don't know what pipe it is; there is one that comes down there, a two (2) inch pipe, and goes into this six (6) inch pipe, and runs right out into the cesspool.

Q. How large a pipe is it? — *A.* Two (2) inch, and goes to the hogshead.

Q. The wooden hogshead? — *A.* Yes, sir.

Q. Stands on the top of the floor at that end of the building? — *A.* Yes, sir.

Q. Then there is something siphoned into this? — *A.* Yes, sir.

Q. Have you ever seen the matter that gets into the hogshead? — *A.* Yes, sir.

Q. What kind, blood? — *A.* I never have noticed any blood in the hogshead.

Q. Been there often? — *A.* Yes, sir; a great many times.

Q. Noticed any blood anywhere there in this locality? — *A*. I have not observed any. I have not taken pains to look.

Q. You have told me all you can about what goes into that cesspool? — *A*. Yes, sir.

Q. How does it get out? — *A*. It runs out in a six-inch pipe, and goes out on this side, and runs across under the track here.

Q. Whatever goes into that cesspool goes out by this six-inch pipe? — *A*. No, sir: whatever runs into there does not run out; the grease is dipped off.

Q. Then they dip off the grease? — *A*. The object of this hogshead here is so that they can dip off whatever grease collects on the top of the water: there is a pipe that goes in, and an elbow fixed in, so that they can dip off the grease at any time.

Q. After they have dipped off what they want, it goes off in this six-inch pipe, and goes into the filter? — *A*. Yes, sir.

Q. What is that? — *A*. It is a wooden box, about fifty (50) feet long, filled with charcoal and gravel, and made water-tight: made of two (2) inch pine plank; it was pine plank, and put together with lead in the corners and edges.

Q. What sort of lead did you use? — *A*. Used white lead.

Q. You think it was about fifty (50) feet long? — *A*. I should say so.

Q. That is about all you know about it practically? — *A*. Yes, sir.

Q. You don't know any thing about the filtering afterwards? — *A*. No, sir.

Q. When you laid that drain-pipe to Alewife Brook, you didn't suppose there was going to be any pressure put upon it by steam? — *A*. No, sir.

Q. And you thought you laid it for ordinary purposes? — *A*. Yes, sir.

Q. It was not at all fitted for steam pressure? — *A*. No, sir: we supposed water was going to only run through it.

Q. Think it strong enough for that? — *A*. Yes, sir.

Q. Were you the mason who advised the row of bricks around the joints? — *A*. I did the work.

Q. You are not the man who Mr. Niles said told him "it was the way to do it?" — *A*. That was the way we had to do it, in order to stop the leak.

Q. Did you lay this other pipe up here on the hill? — *A*. Yes, sir.

Q. You have not had much experience in iron flange-pipes subjected to that pressure? — *A*. No, sir; I have not.

Q. Did they state to you what they wanted to go through that drain to Alewife Brook? — *A*. Whatever drainage came from the buildings.

Q. Did they say to you the particular kind? — No, sir: not that I remember of.

By Mr. Warren.

Q. This brick arrangement around that pipe was made in an emergency, wasn't it? — *A*. Yes, sir.

Robert Burrows *called. — Direct Examination by* Mr. Warren.

Q. You constructed the ice-house and cooling-rooms in Mr. Niles's building? — *A*. Yes, sir.

Q. How much experience have you had in that class of work? — *A.* Quite a considerable.

Q. What is the capacity of this ice-house? — *A.* Something over five thousand tons of ice.

Q. What is the capacity of the rooms? — *A.* Well, one of those compartments, about three hundred and thirty-seven thousand (337,000) cubic feet.

Q. How many cooling-rooms are there in the building? — *A.* There are virtually two (2) besides the cool storage-rooms under the ice-house; the first cooling-room is thirty-six (36) by ninety (90); underneath that the refrigerator, thirty-six (36) by eighty (80); then there are two (2) compartments of thirty-six (36) by ninety (90) each, between those two (2).

Q. The hogs are put into the ice-cooling rooms; the animal heat is allowed to escape first? — *A.* Yes, sir.

Q. How long after the hog is killed, before he goes into the ice-cooling room? — *A.* In the summer-time, almost immediately.

Q. As to the construction of this building, so far as your supervision of it was concerned, will you state the character of the work; that is, I want to know whether it is well done? — *A.* I consider it overdone in some respects: to explain that, I will remark that there were gutters up under the platform to carry off what running water or offal might come there; I mean the unloading platforms, outside of the building; they are made water-tight, with conductors under them to carry the waters off: it looked to me like unnecessary care; that is why I spoke of it as being overdone; the cellars are the most complete I have ever seen, and I have had some experience in that line.

Q. Probably you can tell us something about water-tight filter-basins. Are they water-tight? — *A.* About as near as can be: I should say that they were at the present time perfectly water-tight.

Q. How are they made? — *A.* Two-inch clear pine plank bolted together, with white-lead joints. I was in there Saturday, and the floor was comparatively dry about them.

Q. You take the different floors of the slaughter-house itself: are they as tight? — *A.* Well, mostly so. I noticed where some posts went down, there was a little stain, but only about a foot, on the woodwork. It run down the post to the floor, and it can easily be remedied.

Q. Have you had occasion, in putting in refrigerators, to see some good slaughter-houses? — *A.* Some of the best in the West.

Q. How will this compare with those? — *A.* I think it far ahead of any thing I have seen: I don't consider the Chicago slaughter-houses so complete as these.

Cross-examination by MR. HAMMOND.

Q. How is the hog basement? — *A.* I haven't noticed any leakage.

Q. Is the basement floor tight? — *A.* Yes, sir: it is.

Q. How high up? — *A.* I should say it will hold water about four (4) inches, perhaps eight (8) inches. I should think there were six (6) or eight (8) inch planks put in and made tight; so water has got to go to the top of that plank to get out. I have not noticed that it has ever

been flooded at all. The water I was speaking about on the floor was up above, where they let the hydrant run all night by mistake.

By Mr. Warren.

Q. It was clear water? — *A.* Yes, sir.

Mr. Hammond *resumes.*

Q. Are you connected in any way with these people in this business? — *A.* Only a contract to carry out.

Q. What is your contract? — *A.* In reference to building their ice-houses.

Q. Does it give you any interest in the business? — *A.* No, sir: none at all.

Q. At all interested in the business? — *A.* No, sir: not at all.

Q. What is your business? — *A.* Refrigerator business.

Q. How long have you been in it? — *A.* About two years and a half (2½).

Q. What is your refrigerator building on the plan? — *A.* It is inside of the building.

By Mr. Warren.

Q. How long have you been in this business? — *A.* About twenty-five (25) years; but, to make it a business, about two and a half years.

Mr. Hammond *resumes.*

Q. What did you see that made you think the filter leaked? — *A.* I saw some dampness about the joints, — a trifle: I should say the tanks were as near tight as could be possibly made, with that construction.

Q. They were not tight at first? — *A.* No, sir.

Q. How long before they became tight? — *A.* Soon after the water was in.

Q. Do you know any thing about the drains of the building? — *A.* No, sir.

J. P. Boynton *called.* — *Direct Examination by* Mr. Warren.

Q. Do you have charge of the killing operations out at the factory? — *A.* I do.

Q. Perhaps you can describe in your own way the arrangement for draining the different floors of the main building, beginning at the top floor, and show what becomes of all the liquid that there is in the building? — *A.* We have got from the top floor two (2) four-inch pipes running from there, and one under the floor; one that comes down into the cesspool for washing off the floors, outside between the engine-house and that; and the other one is for the soup, that runs into the iron tank, sitting on the first floor, and is about ten (10) feet long. That is all the drainage we have, from the upper floor, in the third story.

By the Board.

Q. The first goes where? — *A.* One pipe takes all the washing of the floor, and runs down into that cesspool; the other runs into this iron tank

(for the soup). The iron tank is on the first floor; on the second floor we have for the sticking-pen, a trough cut down eight (8) inches into the floor, and the blood runs into this trough, and goes down into this pipe, leading from the bottom of this trough, down into the coagulator.

By MR. WARREN.

Q. The coagulator is an iron tank closed tight? — *A.* Yes, sir.

Q. And there all the blood is gathered? — *A.* Yes, sir.

Q. It is shaped as any rendering-tank, only about half the size? — *A.* Yes, sir.

Q. It has a manhole at the bottom? — *A.* Yes, sir: then there is a pipe leading from where we slaughter; there are two (2) pipes (we have a long trough right at the foot of where we slaughter): one of them is for the blood, and all the bloody parts go down through here into this iron tank, and the washing goes down into the basement, into the hogshead.

By the BOARD.

Q. The second pipe contains what? — *A.* It contains whatever water goes down, and whatever they scrape off after the hogs are hung up. A man stands here to cut the hogs; I have it fenced off like that so that it catches the blood. That is about all there is that comes out of the hog, and that goes down into the iron tank, and then there is another here.

By MR. WARREN.

Q. The water from the bench goes into the — [Interrupted.] — *A.* Hogshead: we skim off all the greasy or light substance as it rises to the top.

Q. The upper story is used for trimming, &c.? — *A.* Yes, sir.

Q. It is divided by a floor, and the "sticking-pen" is at the top? — *A.* Yes, sir.

Q. On this second floor your rendering-tanks hang? — *A.* Yes, sir.

Q. Then your blood is coagulated; there is an opening from that floor leading to the dryer? — *A.* Yes, sir.

Q. So that the course of that blood is from the pig into the coagulator, and from the coagulator into the dryer? — *A.* Yes, sir.

Q. Now, the part that you "try out" is raised by the elevator into the upper story? — *A.* Yes, sir.

Q. And there put into that tank? — *A.* Yes, sir.

Q. How many have you? — *A.* Only one now: we have two (2) or three (3) to put in.

Q. And the soup that is here spoken of is the product of these renderings? — *A.* Yes, sir.

Q. Then the soup-pipe runs from this floor? — *A.* Yes, sir.

Q. Is the soup drawn right into that pipe? — *A.* No, sir; into the iron wagon in the first place.

Q. You let that stand in your wagon until it settles? — *A.* Yes, sir.

Q. And then skim it off? — *A.* Yes, sir.

Q. And then what? — *A.* It runs down through those tubes.

Q. Now, you take the washings from each floor, — you said the wash-

ings from the upper floor are carried down into the pipe, between the two buildings; how large is that pipe? — *A*. Four (4) inches.

Q. And that takes the washings of the story on which the hogs are killed? — *A*. Yes, sir.

Q. Is that the principal amount of washing that there is? — *A*. Yes, sir: there must be some washings from the lower floor that we have not piped yet, because we have not used it.

Q. The pipes you run into the same place? — *A*. Yes, sir.

Q. It is on that floor that the hogs are dressed? — *A*. Yes, sir; second story.

Q. Does this discoloration come from the washing? — *A*. Yes, sir; but a little blood would color a large amount of water; in the washings from the hog-bench, there is no such discoloration.

Q. Is it all clear water that is used on that floor, aside from this little discoloration? — *A*. Yes, sir.

Q. Can you tell how much water you use in a day? — *A*. No, sir.

Questions by the BOARD.

Q. That water from the hog-bench is foul water, I suppose? — *A*. That runs down, and goes into the cesspool.

Q. When you empty the scalding-tanks there, it goes into the soup? — *A*. Yes, sir; but the washings go on to the floor and down into the cesspool.

Questions by MR. WARREN.

Q. Have you used this soup-pipe since it has been put up? — *A*. Yes, sir.

Q. How long have you been using it now? — *A*. I think Saturday was the first time we used it: I don't know whether it was Friday or Saturday; we have not used it but a few times.

Q. How has that operated so far? — *A*. Perfectly tight.

Q. Have you been upon the hill yourself? — *A*. Yes, sir.

Q. What was the appearance where the soup had been delivered on to the muck-beds? — *A*. We dug out trenches, and the soup is thrown into them; the muck then is thrown back to cover it. We don't put any very large amount in one trench: the trenches are shallow.

By the BOARD.

Q. How large a space do these trenches cover? — *A*. About fifteen (15) inches wide, and perhaps twelve (12) or fifteen (15) inches deep.

Q. How large a surface in extent? — *A*. We have three muck-beds: in one of them there are a hundred cords, and I should think it must be five feet deep, and, I think, about five or six rods square; the others are considerably larger and from four to six feet deep.

By MR. WARREN.

Q. Are the trenches close together? — *A*. About twelve or fifteen inches apart, and about the same depth. We take the muck out of one, and lay it up on the other; and then we put the soup on. There is loam under these trenches, about three or four feet deep, I think.

Q. Does the soup strike to the bottom of it? — *A*. I don't know; we have not worked it long enough yet: my idea is, when we get the top saturated, to go over that, and come back, and take that part that has not been dug, and throw in more, until we find the material is thoroughly saturated.

By the BOARD.

Q. How often does that tank get filled up? — *A*. About half full every day.

Q. Can you use all of that up in the muck? — *A*. Yes, sir: I have no doubt that we can.

Q. You have to spread it over a sufficiently large surface, so that it won't smell, or any thing of that kind: can you do that? — *A*. We intend to do that: probably we shall dispose of quite a large quantity, as a number of people have signified their intention to buy it and take it away.

Q. Your trenches are large enough to discharge all of this matter? — *A*. Yes, sir.

By MR. WARREN.

Q. Have you ever tried carting away this soup to any other place? — *A*. No, sir; we have had no opportunity: but they do from the abattoir in Brighton.

Q. Who cart it away? — *A*. A glue-manufacturer carts it away every day.

By MR. HAMMOND.

Q. It must be carted away fresh? — *A*. (MR. WARREN *replies*.) Certainly: it is carted away to be used in making glue.

MR. WARREN *resumes*.

Q. It is necessary to have a cart always on hand to receive it? — *A*. Certainly: my tank is so situated that I can run a tube from the tank into the cart.

Q. Have you ever used the dryer? — *A*. I have.

Q. Did an accident happen to it when it was first put up? — *A*. Yes, sir: the first time it was put up it leaked.

Q. In consequence of the leak, what did you do? — *A*. We had to take the contents out on to the floor before they had dried, and have the dryer[1] calked.

Q. Would that material in that shape cause an offensive smell at that time? — *A*. It would; yes, sir: no question about that.

Q What appeared to be the fault? — *A*. The dryer was not thoroughly calked around the doors, and then around the shaft it was not tight.

Q. Was that remedied? — *A*. It was: the party who made it came over, and made it tight.

Q. Has it been in use since? — *A*. Yes, sir.

Q. And it is in condition for use now? — *A*. Yes, sir.

[1] A patented dryer, — a cylinder in which steam-heated pipes revolve, with a pipe from the top through which the aqueous vapor and gases pass to the condenser, and the gases thence to the furnace-fires.

Q. Now, about the drain-pipe leading to the brook: when you first put that in, did you expect to have to use pressure on it?—*A*. I did not.

Q. Since it has been relaid, have you used it?—*A*. Yes, sir: the very first day; since then, I put in a large hogshead, or cask, to experiment on this flow, and pumped it from the filter into the hogshead, and it runs off the natural way.

Q. How much head do you get now?—*A*. I think we get about thirteen feet: I am not positive about the exact amount.

Q. Has there been any interruption in the flow?—*A*. Only in that one instance, when the bricks were blown off of the "T" we had put in.

Q. What arrangements have been made to prevent a repetition of such an accident?—*A*. That one was bricked around; now we are going to get iron caps and fasten over them. I understand they fit with some kind of a fastening that I am not familiar with.

Q. Is there any possible chance, short of an actual crack in the floor, in the ordinary carrying on of your business, for any of the liquid product, or of the water used, getting into the ground?—*A*. I don't see any.

Q. If either drain should burst, there would be difficulty until it was repaired?—*A*. There would be no danger from the slaughter-house by it; if there is any drain to burst, it would be the one leading to Alewife Brook; but we got Walworth to send us out some calkers whom he recommended as being thorough: they used about thirteen hundred pounds of lead, and they were three days about the job. I think it was done very thoroughly.

By the Board.

Q. The cesspool is tight, is it?—*A*. I think it is, because I have watched it every morning, and I have never seen tho water below the pipe in the cesspool.

By Mr. Warren.

Q. Two (2) of the witnesses have testified to having detected some smell from the place: has there been any time when there has been any cause for that, except when there was a leak from the drying-tank, that you know of?—*A*. We had considerable offal, plucks and such kind of stuff; and, of course, that stuff had to lie until the pipes were repaired, which caused some smell for a day or two.

Q. Was that owing to the interruption caused by the leakage?—*A*. Yes, sir.

Q. You went with Mr. Niles to see Professor Sharples before you began?—*A*. Yes, sir.

Q. Will you state what took place?—*A*. Mr. Niles thought it was not safe to go on there, without getting some scientific man to examine the premises. I recommended Professor Sharples, as, he being a chemist and a Cambridge man, his prejudice would be on the side of the city. Professor Sharples said, "I don't want you there; I don't think it is any place." I said I didn't want his advice in his office in Boston, but I wanted him to go on to the premises. He said he would do so. I went to his house, and carried him up on to the premises. He wanted to know what I intended to do, and I gave him a little explanation that

I was going to cement the cellars; the soup I proposed to treat chemically (I have a process by which I can take out five per cent of the matter). He started and examined the whole premises, and we then sat down together, and Professor Sharples said, "I should suggest, instead of using the chemicals, — I should suggest a ditch down through the swamp, instead of going around to a point on the railroad-track, and dig out that culvert, and let the water off into the brook; then I should suggest for you to pump your soup on to the hill that belongs to Mr. Heywood." "Dig out this mud, and," he said, "it would make the best fertilizer in the world;" and said, "if you cement your cellars tight, I see no reason why you cannot do business as well here as anywhere."

Q. Did you say any thing to him about superintending the work, or coming up there to advise you? — *A.* I am not certain whether I did at that time: I did at the next interview.

Q. Where was that? — *A.* In Boston at his office; I told him that we should like to have his advice concerning the construction of the drains, sewerage, and all that. He said, if we were allowed to build, he would do it; but after that he declined to have any thing to do about it, because, he said, he was mixed up with the Cambridge Water Board, so he could not very well work for both; but he said he could recommend a Mr. Avery that would do just as well as he could. Mr. Avery was in his office.

Q. Did you make, in any manner or form, any intimation to him about employing him, or paying him any price, because he was employed by the city of Cambridge? — *A.* No, sir: I think at the time he told me that he could not do any thing for us; I then offered to pay him for his services, or at least for what he had done.

Q. Did you offer to pay him any particular amount? — *A.* No, sir: I looked into my pocket-book, and saw that I had not any bills, but I had a check, which I tendered him to take his pay out of. He said he was would not take pay; he was in the employ of the city of Cambridge.

Q. Any thing said about pay after that? — *A.* No, sir: I took half a day of his time, and supposed we had got to pay him for it.

Q. Before going there, did you make any inquiries among the neighbors as to whether the place would be objectionable? — *A.* Yes, sir.

Q. Did any neighbor make any objection to it? — *A.* No, sir.

Q. Did you go around to get signatures of the people of Belmont, to get your license? — *A.* I did.

Q. How many men did you get? — *A.* 178, I believe.

Q. All voters or tax-payers? — *A.* Yes, sir.

Q. Were they all householders? — *A.* No: they were tax-payers or voters.

Q. Who is the nearest neighbor there? — *A.* Mr. Black.

Q. Did you get Mr. Barker? — *A.* No, sir: for I did not know he lived there; I asked Mr. Heywood about going to those people, and he said that they were all right.

Q. Besides this house of Black's, is there any dwelling-house in this vicinity? — *A.* Not very near; there is a small house of a Frenchman's, though; but the next nearest is up almost to the corner of Brighton

Street; it is the Stearns property; then there is a house right opposite, where they said they had no objection, and signed our petition for a license.

Q. So that all the opposition has come from the city of Cambridge and the Tudor Ice Company? — *A*. That is all I know of.

Q. How is it with the other ice company? — *A*. They have always been friendly; the Hittinger Ice Company signed the petition.

Q. Which is nearer you, the Hittinger Ice Company, or the Tudor Ice Company? — *A*. The Hittinger. The Tudor Company have a small house that is nearer the road; otherwise than this the Hittinger Company is a quarter of a mile nearer.

Q. Have the Board of Health of Belmont visited the place since it was built? — *A*. I have seen two of them there at different times, not officially; the chairman I have never seen there.

Cross-examination by MR. HAMMOND.

Q. Did not you know that there was a remonstrance presented before the selectmen? What did Heywood say to you about it? — *A*. I was comparatively a stranger there at the time.

Q. Did he not advise you, or apparently desire to have you go there? — *A*. I presume he did.

Q. Black had been working for Heywood for a good while, had he not? — *A*. I was not aware of it.

Q. Did you not know that he was Heywood's man, for the sale of that ground? — *A*. No, sir.

Q. When Hittinger signed the paper, he supposed you were going to buy ice of him? — *A*. I do not know. I told a number I should buy ice of Gage, Hittinger, or Black, one of them.

Q. You have now; but that idea was taken into consideration when they signed that petition? — *A*. I don't know.

Q. You did not go around with the petition until after you had started the building, did you? — *A*. No, sir: not until your petition was presented.

Q. Your building was partially constructed before the hearing? — *A*. We were putting in the foundation: my impression is, that most of our contracts were made.

Q. You got that petition to be used before the selectmen there, did not you? and is it not a matter of fact, that there are but very few buildings indeed, anywhere near that slaughter-house, in the town of Belmont? — *A*. The only buildings that are near are in Belmont.

Q. I understand that you stated that upon the second floor [pointing to map], the blood goes from the sticking-pen into a coagulator, and that about thirty per cent of what goes into the coagulator, you take out: it doesn't go into the dryer at all, but goes into this iron tank? — *A*. Yes, sir.

Q. And finally goes into the filtering-basin? — *A*. No, sir: goes up on the hill.

Q. Then I understand that after the hog is stuck, he is put in and scalded? — *A*. Yes, sir.

Q. Then that water goes into the soup, up on the hill? — *A.* Yes, sir.

Q. That after that, he is taken out, and hung up, and washed, and scraped down? — *A.* Yes, sir.

Q. And that is done over the floor? — *A.* On the second floor.

Q. And I understand that whatever goes from that finally gets into the filtering-basin? — *A.* No, sir: not all of it: around this circle (pointing to map), a man stands to cut them down; I have a partition on the floor, where the blood goes into that iron basin, or tank, right there on the first floor.

Q. How long does it stay there? — *A.* Until we pump it on the hill.

Q. You don't pump it every day on to the hill? — *A.* Certainly.

Q. Then after that the hog is carried out here, and scraped, and washed, and hung up? — *A.* Yes, sir.

Q. Whatever blood goes from that, finally goes into the filtering-basin? — *A.* Yes, sir: a very little would get there.

Q. Now, what do you do with the inside of the hog? — *A.* The fat is taken off, and the rest is removed.

Q. The insides you render on the third floor? — *A.* Yes, sir: all the inwards are rendered in tanks on the third floor, and then emptied into this tank on the second floor.

Q. The soup that comes from that is carried from there, and up on to the hill? — *A.* Yes, sir.

Q. On the third floor, is there any chance for blood there, or offal, or any thing of that kind? — *A.* No, sir.

Q. You cut up, don't you, and handle the entrails, and all that? — *A.* No, sir: we have two pipes running down, and the entrails are stripped up on them, and the manure washed out. Then they are put in the rendering-tank.

Q. The contents of the intestines? — *A.* No, sir: the intestines.

Q. The contents pumped up on the hill? — *A.* No, sir: here is an iron box which sets under the water-pipes: we strip the entrails on the water-pipes, and wash them, and then the manure is taken out on the hill.

Q. That hill not only gets soup on it, but excrement from the intestines of the hog also? — *A.* Not very much: not more than two or three bushels every day.

Q. How many hogs do you slaughter a day? — *A.* On an average, a little short of two hundred a day.

Q. You are prepared to slaughter four or five hundred? — *A.* We might *kill* so many, but have not room to hang them up in the hanging-room.

Q. And then all the excrement in those hogs is carted on to the hill? — *A.* Out of one hundred, there would not be two bushels of matter to be carted up there.

Q. You carry it up, and mix it with muck? — *A.* Yes, sir.

Q. How much do you mix if the muck is frozen? won't it lay there as a heap? — *A.* No, sir: we should cover it.

Q. Do you cart that up there daily? — *A.* About every three or four days: the box holds enough for three or four days.

Q. Until your box gets full? — *A.* Yes, sir.

Q. Now, if a hog comes dead, you put him right into that rendering-tank, don't you, and the soup goes right on the hill just the same?—*A.* Yes, sir.

Q. How can you account for the fact that when your drain did burst there, blood went into Alewife Brook? where did the bloody matter come from? what part of the establishment must it have originally come from? the bench, must it not?—*A.* No, it did not; for after we broke up for the first time, we killed some hogs, and the boys let it down (bloody water) into the cesspool to get rid of it.

Q. You kept on slaughtering pigs, notwithstanding you were out of kilter?—*A.* No, sir: the first burst, we thought, was occasioned by a weak spot in the drain: we stopped work, and took it up to see what was the matter; we put a pump on, and it burst and blew the packing off in two or three places, and we repaired it, and the next day tried again, and had the same results: then we came to the conclusion, that there was another way, and that was to take the pipe up, and calk it with lead; what hogs were killed the day before, the offal had to lay until we fixed the drain; we did not kill any, Friday or Saturday following the break.

Q. You did not have any there?—*A.* Yes, sir: I think there were.

Q. Have you not kept right on killing hogs before you were ready?—*A.* No, sir: the dryer did not come so early, up to about ten days, as we expected, and I ordered some hogs on that expectation,—that the dryer would be ready at the time promised; and, when the hogs came here, I supposed we had to take care of them.

Q. You speak of making provision in case your pipe gets filled up; can you state to us the state of things likely to happen, to fill that pipe up?—*A.* Having about twelve or thirteen feet head, it must give plenty of pressure; so I see no reason why it should trouble us, and I have the pipes incased.

Q. Blood must of necessity be more or less in that drain-pipe?—*A.* But very little; very little blood will color a large amount of water.

By Mr. Warren.

Q. Manure that is taken from the intestines, &c., is it any different from ordinary manure that is mixed and used for dressing and putting on the ground?—*A.* No, sir.

By Mr. Hammond.

Q. Your muck-heaps are not covered?—*A.* No, sir: we shall probably cover them when it comes time.

By the Board.

Q. All the ice that you use, shall you freeze it yourself?—*A.* We mean to buy it all; all but a very little.

Q. From Fresh Pond, or the Glacialis?—*A.* Probably from Fresh Pond, but perhaps also from Spy Pond.

Q. Is the Glacialis still used for ice?—*A.* I am told not; not for many years.

Q. Was it used for some years? — *A.* I don't know personally; but have been told that there has not been ice cut there for a great many years; their ice-house is rotted down; I believe the ice was not clear.

Q. When you render dead hogs, do you scrape off the hair first? — *A.* No, sir; we render them with the hair on.

Q. About this dryer: when this dryer was out of order, you had no blower to draw off the gases? — *A.* We had a blower.

Q. Does the condenser work well? — *A.* Yes, sir.

Q. Is there any method of drawing air into this conductor from the condenser to the blower, so as to mix air with the gases? — *A.* I don't know. I have merely mentioned it to the engineer. He said it was a very close condenser.

Q. Do you know now, practically, whether the gases are consumed when they go under the boiler? — *A.* Personally, I have not had time to examine it; our engineer says it is all right.

By MR. HAMMOND.

Q. Were you all right Thursday of last week, the day before the hearing, in respect to the smells? — *A.* When this stuff had accumulated, it was drawn out on to the floor, and it smelled a little; when we first drew it out, we could not help a little smell, but not after the steam got out of it; it don't smell when we draw out *fresh* stuff.

CHARLES D. ELLIOT *called. — Direct Examination by* MR. WARREN.

Q. You are a civil engineer? — *A.* Yes, sir.

Q. And have made some observations in regard to these matters, that have been under discussion before this Board? — *A.* I have; yes, sir.

Q. What can you say about water-levels, by which I refer to underground water? Give, if you please, such information as you have been able to derive from your own observation or from Mr. Barbour's table. — *A.* I have made some observations upon the ground-water, but nothing systematic. I have taken this morning some levels at the old well that is within ten feet of the corner of the engine-house, at Alewife Brook under the Fitchburg Railroad and under the Lexington Railroad, and at other points; the height of the water surface in the muck-pit is 15.87; in the well, 15.14; in the conduit, 14.90; at Alewife Brook under the Fitchburg Railroad, 15.50, under the Lexington Railroad, 15.12; and at the bottom of this muck-pit it is 7.37. These were all taken to-day. The basement floor of the hog-house is 16.66. The basement floor of the slaughter-house is 20.00; the next floor, where the office is, is 27.85, that is the floor on which the drainage-cask stands; the bottom of the drainage-cask is 27.85. [These figures show height in feet above Cambridge base.]

Q. Is that the floor to which the sewage is pumped, to take its start in the drain? — *A.* It is.

Q. Can you give us the level of your base, or 0? — *A.* I think Mr. Barbour can tell you better than I.

MR. BARBOUR *replies.*

A. I think we called our base 5.6 feet below mean low-water level.[1] I merely give you this from recollection: between mean high tide and spring tide, the difference is two feet; between mean low tide and lowest spring tide, less than two feet.

MR. WARREN *resumes the examination of* MR. ELLIOT.

Q. You will go on and finish? — *A.* Sept. 7, the level of the water surface in the swamp near the hog-house was 14.79.

Q. What else have you to-day? — *A.* The height of the drain where it enters the hog-house is 18.83; the top of the tank in the hog-house, 19.66; top of filter-basin, 18.91; the drain where it leaves the hog-house, 18.12; the mouth of the drain at Alewife Brook, 13.00.

Q. Can you give me the fall of the drain-pipe? — *A.* The fall from the top of the filter-basin to the surface of the water in the brook, as it is to-day, is 3.41; the surface of Alewife Brook is 15.50 to-day.

Q. Then give us the fall from the cask, the actual fall. — *A.* 12.35 feet from the bottom of the cask, and the cask is four feet high inside.

Q. I understand, that, before leaving the premises, all that has gone through the filter-basin is returned to the first floor, so that it gets that velocity? — *A.* Yes, sir; it must get about fourteen feet head on an average.

Q. Is there pressure enough from a stream having such a head to blow out the top of these T's? — *A.* No, sir: it has only a pressure of six or seven pounds to the square inch.

Q. Then, so far as we can see, that pipe will work well? — *A.* Yes, sir.

Q. Will iron caps stand the use of steam if necessary? — *A.* Yes, sir.

Q. Were you present at the time of re-laying the drain, and did you see some of the joints that were finished? — *A.* Yes, sir. I looked at every joint, I think.

Q. In your opinion, that pipe is all right? — *A.* Yes, sir.

Q. How is it about the pipe that has been laid to carry the soup on to the hill? — *A.* I don't know, sir; that is a steam-pipe, and the steam engineer had charge of that.

Q. Have you looked at it since? — *A.* No, sir.

Q. Now, have you any other levels taken? — *A.* I believe I have no other levels that are of any particular service.

Q. Have you examined that hill on which the muck-beds are — this slope [facing east toward the slaughter-house] — with a view to ascertain what the material is? — *A.* I have.

Q. What is the result of your examination? — *A.* This morning I examined it very carefully. I find it is very largely composed of clay, beginning here at the conduit [B], and running to a point a hundred feet or more beyond the soup-pipe; I find where the water has trickled down the sides of the bank, large lumps of clay; I should say that about three-quarters of the face of the bank[2] presents clay, and that clay lies here in

[1] 5.624 exactly. [2] On the line of excavation *h h*, nearly.

one large deposit; and there seems to be a little clay all along underneath the surface, and also a stratum of clay at this corner near the conduit.

Q. Have you examined the soil elsewhere about the premises on these swamps? — *A.* I know generally about them.

Q. Do you know what they found at the foundations? — *A.* They found gravel: it was very firm, and the contractor was obliged to pick, in order to excavate it. The contractor based his calculations on shovelling only, and complained of having to use the pick. After we had got down here six or eight feet, they came in contact with blue gravel (in the ice-house cellar).

By the BOARD.

Q. How low down was it, the clay in the bank?[1] — *A.* I should think four or five feet, all along here. Along here, for a space of twenty feet, is a bed of it running down to the bottom of the slope, and then along here on the slope it seems to run three or four feet wide; then it runs down again to a point near the conduit: I have not examined over the other side of the street.

Q. Taken in connection with your observation of the soil of the whole, have you made any comparison with the water levels as shown by Mr. Barbour's plan? — *A.* I have looked them over.

Q. What result have you been able to gather from his observations and from his diagrams? — *A.* I have found that the water in well No. 1, in the majority of cases from Oct. 14 to Dec. 18, is lower than the water in well No 4; that is to say, that from well No. 4 there is a general fall in the ground water towards No. 1. That well No. 1 is constantly lower than No. 3 and No. 2, and that there is a constant fall from No. 2 in the direction towards No. 1. The ground water here seems to be running away from the conduit instead of towards it.

Q. Any other observation? — *A.* That on 31 or 32 days, as those sections show, the water in well No. 1 was lower than the water in well No. 4 at the conduit, and on one day the water in well No. 1 was within one or two hundredths of the level of the water in the pond; that was Nov. 24, 1878.

Q. Was it below or above it? — *A.* .02 (two one-hundredths) above the water in the pond; and on two other occasions it was lower than the water in the pond, Nov. 21 and 22.

Q. Is there any open water around here lower than the pond? is Wellington Brook? — *A.* (MR. BARBOUR answers, that "that brook is a very variable one, sometimes higher and sometimes lower.")

Q. Have you made any other observations on those waters? (to MR. ELLIOT.) — *A.* With reference to the rise of the water in well No. 5, as compared with the pond and the conduit, on Oct. 23, the sections show that there was rain, and that No. 5 took a sudden rise of .76, and the pond also took a slight rise of about .2 at the same time. On Nov. 17 and 18 there were rains also, and No. 5 took a greater rise than before, from 13.88 to 14.75; and the pond also took a rise on these two days,

[1] The bank referred to above.

from 13.39 to 13.48, and next day after that to 13.73, showing in three (3) days .34 difference, and a rise in well No. 5 of about .9 foot. On Nov. 22 there was also a rise in well No. 5, after a rain, from 14.56 to 16.08, and the pond rose .2 (two-tenths). On Nov. 28, well No. 5 rose from 15.56 to 16.16, with a rise in the pond of .12. And on Dec. 2 well No. 5 rose from 15.84 to 16.16, with a corresponding rise in the pond as before. The action of well No. 5 is, after a rain it rises, and then subsides until the next rain, and then rises again, and then subsides, and then rises, &c.

Q. Have you any indications of the underground water tending practically toward the pond? — *A.* No, sir.

By the BOARD.

Q. Can you explain the difference between No. 5 and No. 4 wells? — *A.* I should say that the indication of these lines of the section here was, that the water flowed in this direction [from wells No. 3, and No. 2 towards well No. 1, or away from the conduit and pond].

Q. Why should the difference be so great between No. 5 and No. 4, and so little between the others, comparatively? — *A.* I should expect to find less variation at those wells No. 5 and No. 4: it may be that there is an impervious layer between No. 4 and No. 5. It is hardly possible, without making further observations myself, to explain it fully: I should rather state the facts.

By MR. WARREN.

Q. Have you made any other investigations, or rather observations, in regard to the water levels over that territory, or anywhere else? — *A.* No more except to notice this fact in the levels of Mr. Barbour, that there seems to be a fall in the natural water surface in a general direction from the slaughter-house northeasterly towards Alewife Brook.

Q. Have you had occasion to compare the general surface direction of water with the underground direction? — *A.* No, sir. Every case is special: there is no universal law of comparison.

Q. You wouldn't act on one, then? — *A.* No, sir.

Q. Can you tell us the amount of water that is discharged by the Cambridge sewers at Alewife Brook? — *A.* Very roughly I should say, 1,500,000 gallons per day, through the three sewers of Concord Avenue, North Avenue, and Spruce Street.

By the BOARD.

Q. What is the area drained? — *A.* The City of Cambridge show in their report what the area is: here it is [shows and reads report]. 290 acres Concord Avenue, 283 acres Spruce Street, and 182 acres North Avenue: every thing there goes through the sewer.

MR. WARREN.

Q. How thickly are these areas inhabited around the mouths of those sewers there? any houses at all? — *A.* No, sir.

Q. For some distance? — *A.* Some parts rather sparsely settled, other

parts rather thickly settled. I think the map will show better than I can state, — the map of the city.

Q. Now, what is the effect of these eight (8) wells which were driven? have you perceived the effect of those? — *A*. I have not taken any observations: I should think they would have the effect to draw — [Interrupted.]

Q. Is Professor Nichols's report about fair? — *A*. I never made any observations, but that is about as I understand it. I think it is a common-sense view, and substantiated by actual observations taken by competent parties.

Q. The effect of that would seem to be, to draw *from* this conduit instead of *into* it? — *A*. Yes, sir: I should think so.

By the BOARD.

Q Do you know how much is pumped from these eight (8) wells in twenty-four hours? — *A*. No, sir.

(MR. WARREN remarked to the Board, that he should very much like to know, or approximate as near as possible to the amount, in order to make comparisons.)

Cross-examination by MR. HAMMOND.

Q. Have you examined those diagrams to see whether the water is tending across the conduit? — *A*. Well, I think in nearly every case that from well No. 4 tends toward the conduit, and from No. 5 also.

Q. Then it shows that the tendency of the water from this slaughter-house is to go towards the conduit? — *A*. Yes, sir, if it shows *any thing*.

Q. And don't it show, as a rule, if the conduit is porous, if the water can get into the conduit, water from under the slaughter-house could come to it? That is the general direction? — *A*. Well, I don't know as it follows that the water *under* this slaughter-house will.

Q. It rather indicates it, don't it? — *A*. This well No. 5 is little nearer the conduit than the slaughter-house, and, taking the extent of the slaughter-house into consideration, it is hardly fair to make such a conclusion.

Q. At that part of the slaughter-house which stands upon a gravelly foundation, you don't think the water tends in this direction? — *A*. I hardly think it does.

Q. Then it tends that, or some other way? — *A*. I think that the surface is impervious, or practically so, along there, and that it has been so compacted by teams, that it forms an impervious dike.

Q. Does the water under the slaughter-house go *anywhere?* — *A*. That is a question. It might go to this low piece of ground.

Q. The surface water is not a very safe guide as to ground-water direction, is it? — *A*. No, sir.

Q. Isn't it the tendency of the clay to run towards Fresh Pond here? — *A*. There is at present no way of telling which way the clay does run.

By MR. WARREN.

Q. What are the shores of the pond around here? are they steep at all? — *A*. I cannot tell.

By the BOARD.

Q. When you made comparison between the water in this excavation, and the well No. 5, do you know the height of the water in the conduit at that time? wasn't the water still higher? — *A*. No, sir; I don't think it was: I think in every case the conduit was lower than No. 5.

By MR. HAMMOND.

Q. Those wells, have they struck down below the clay foundation? — *A*. I don't know.

Q. I suppose those wells take their supply from a place below the clay: they then would not draw the water that is above the clay? — *A*. They might, or might not: I know of cases where wells have drawn top water.

By the BOARD.

Q. Have you the size of the filter-bed? — *A*. Yes, sir: there are three hundred and forty square feet of surface in the filter-bed. Capacity of drain is about two thousand gallons per hour, and the cask contains about three hundred and forty gallons.

By MR. WARREN.

Q. You found the area of the muck-beds? — *A*. No, sir; I have the area of the loam-bed.

Q. What is that? — *A*. It averages about 55 × 75 feet. I will give it to you in quantities: there are in the loam-bed about 590 cubic yards, and 1,920 in the muck-beds.

Q. Have you made any calculation as to the absorptive power of that loam? — *A*. I never have; no, sir.

Q. Have you any other facts to state? — *A*. I don't think of any thing more.

By MR. HAMMOND.

Q. What you stated about the supply of the Cambridge sewers, you judged they took in the surface water and every thing else: you don't know how much is surface-water, and how much isn't? — *A*. No, sir.

MR. GEORGE DAVIS *called*. — *Examination by* MR. HAMMOND.

Q. You are in the office of the city engineer of Cambridge? — *A*. Yes, sir.

Q. You have made observations about that little pond? — *A*. Yes, sir, I have taken some measures.

Q. Does it strike gravel anywhere? — *A*. Yes, sir.

Q. Where? — *A*. On the westerly side.

Q. At what depth? — *A*. As far down as the rod would reach; about eight and one-half feet.

A. When did you examine it, — lately? — *A*. Yes, sir.

(Hearing was here adjourned until Friday, Dec. 27, 1878, at eleven o'clock A.M., to hear the arguments.)

FRIDAY, Dec. 28, 1878.

Mr. Hammond stated that in accordance with the desire of the Board, Mr. Barbour had made some experiments with a view to ascertaining the character of the soil, and with reference to the difference between the water-levels of wells No. 1 and No. 5; and, if it was the general wish of the Board, Mr. Barbour would take the witness-stand for a few minutes before the arguments took place.

The Board requested that he be asked to do so.

MR. BARBOUR *called.* — *Questions by* MR. HAMMOND.

Q. You will please state to the Board, in your own way, what you found in well No. 5, what you did, and the result. — *A.* The explanation of the height of well No. 5 is, that it was stopped up.

Q. Did you make some exploration in the clay? — *A.* We made some for clay.

Q. Where did you sink the hole? — *A.* We sunk a hole near the second manhole from the pond.

Q. Was that the only hole you sunk? — *A.* We made some soundings with a sounding-iron.

Q. Where did you make them? — *A.* One sounding at that point, on the edge of the pond, near Black's Nook.

Q. How far down did you go? — *A.* Nineteen and one-half feet below the surface of the water in Fresh Pond.

Q. Find any clay? — *A.* Found gravel overlaid with mud.

Q. Where is the next place? — *A.* At a point there near that culvert, five and one-half feet away, between the borders of Fresh Pond and Concord Avenue.

Q. Did you find clay there? — *A.* At twenty-four feet a very thin stratum of clay about six inches in thickness; at twenty-five feet we were through, and into gravel.

Q. Any other place? — *A.* One on the northerly side of Concord Avenue, perhaps two hundred feet from the pond. That was at nine and a half feet; found gravel there.

Q. Did you find clay? — *A.* No, sir.

Q. How deep did you go down? — *A.* Nine and a half feet.

MR. WARREN.

It is marked on the map, gravel or clay.

By MR. HAMMOND.

Q. Did that cause you to disagree which it was? — *A.* I thought it was gravel; my assistant took it. (*Assistant called, and said*) It was very hard, and I could hardly tell whether it was mixed clay and gravel, or all gravel. (MR. BARBOUR, *witness, continues*) We found clay, with gravel-stones mixed with it. I am very well satisfied it is gravel: it had every appearance of it.

Q. What other point did you make? — *A.* We made another one near the edge of the bank, a hundred feet farther towards the slaughter-

house, just inside of the property line, in the mud near the edge of the upland. That is marked eight feet. We found the same mixture; we couldn't bring any thing up; couldn't get the rod down there.

Question by MR. WARREN.

Q. Would that be what ordinary contractors call "hard-pan"?—*A.* It was compact gravel.

By MR. HAMMOND.

Q. You didn't make examination enough to know, did you?—*A.* I don't think I did, sir. .

Question by the BOARD.

Q. How near did you go to the slaughter-house?—*A.* As near as we could: I have one or two others taken near the slaughter-house; perhaps gave the same results.

Question by MR. WARREN.

Q. We find a line of clay, I think, running in this direction, and also find a line of clay along here; and, taken in connection with the testimony of the man who built the conduit, it would look as if there was a line of clay along here. I think that your conclusion is, that you cannot find out satisfactorily without digging the ground all up?—*A.* I think it would require more careful examination to enable correct conclusions to be drawn.

MR. HAMMOND (*presenting profile*).

There is a profile of Dec. 26, 1878. There is the surface of the ground; this blue line represents the water-line; that line represents the height of the pond, which would be a little lower than the underground water. Here are wells Nos. 1, 2, 3, 4, 5. On punching the bottom out of well No. 5, it went right down to the level of the rest. That surface is artificial at the railroad line between the buildings, and this profile is three times the longitudinal scale of the others.

Question by the BOARD.

Q. Was the bottom of No. 5 stopped up when those observations were made?—*A*: Yes, sir; but the difference in levels may have been due in part to evaporation and other circumstances.

MR. ELLIOT *called.*—*Questions by* MR. WARREN.

Q. I will ask you, Mr. Elliot, to make a statement of some observations that you have made in regard to the clay, &c.—*A.* I will state that between the engine-house and the conduit, about thirty feet out from the engine-house, we found clay within eighteen inches of the surface, and at about forty feet from the conduit, I should think. We dug down with pick and shovel, and found a clay-bed: it is there now, and will show for itself.

Q. Did you bore down near the hog-house?—*A.* Yes, sir:- it appears to be a mixed clay and gravel there.

Q. How deep?—*A.* I think Mr. Barbour's assistant, Mr. Davis, can tell you. (MR. DAVIS remarked that he should think about five or six

feet.) (MR. ELLIOT *continues.*) And at that point I should say we found it eight or ten feet deep.

Q. Did you come to water when you had dug down eight or ten feet? — *A.* No, sir. I will make a statement regarding finding clay down here [where the railroad from the slaughter-house eastward intersects the margin of the swamp]. At this point we struck clay in laying the drain, and then came into gravel; and afterwards, up this bank [north of the railroad and east of the slaughter-house], we found clay.

By MR. HAMMOND.

Q. Do you agree with the other engineers about these tests here? — *A.* Yes, sir: except that one in there at about that point [between the slaughter-house and conduit]. We certainly did strike clay very near the surface. You will find ordinary gravel here. In taking our soundings over here, we had three men on the rod, and it was impossible to penetrate the "hard-pan" [south of the slaughter-house].

By the BOARD.

Q. Would it be a reasonable inference from your soundings and observations, that there might be a clay ridge dividing wells Nos. 4 and 5? — *A.* Yes, sir.

By MR. HAMMOND.

Q. Is it safe to draw any? — *A.* I don't know that it is: I think, with Mr. Barbour, that it is necessary to make a much more thorough investigation. It is a large tract of country, and the strata are very much mixed, being of gravel, sand, and clay, and are so irregular that it strikes me as impossible to get at any very fair conclusion from present data. There is one fact that is generally known, and that is, that the general tendency of all ground-water is towards the *seacoast;* and I think you will find it tends so in this case.

MR. WARREN (*presents a map to the Board, and says*)

This is a profile map; this the water near the conduit, and this the water of well No. 5; and that is a point above the bottom of the muck-pit; and the muck-pit at this point is dry. This map shows the relative height and distances. Now, —

Q. On those dates that you made observations, was there any water running from the direction of those wells into the muck-pit? — *A.* No, sir.

Q. Wouldn't your observations, and those taken, don't they all tend to show an impervious wall between this point and that point? — *A.* Yes, sir: they tend to show no communication of ground-water between the muck-pit and well No. 5.

Q. There is only one other question suggested; that is, I don't suppose that well No. 5 got stopped up by any other than natural means? — *A.* (*By* MR. HAMMOND.) No, sir: we make no unfair statements. (MR. WARREN.) I make no charge of unfairness. The matter simply suggested itself to me.

MR. WARREN'S CLOSING ARGUMENT.

Mr. Chairman, and Gentlemen of the Board, — I am aware how irksome it would be to you, who have devoted so much time and attention to the investigation of questions in regard to the pollution of water-supply, the drainage of cities and towns, and the conditions, restrictions, and regulations under which certain trades are to be carried on in this vicinity, were I to go over in detail the testimony that has been produced here, to establish certain general propositions, already adopted by your Board as conclusions and bases of action: I take it for granted, that whatever your Board has asserted in its series of annual reports to the Legislature will be regarded by you as established fact, for the purposes of this hearing; always excepting any modification of earlier opinions or theories, which subsequent investigation may have shown to be required.

I adopt as my own, for the purpose of this argument, the conclusions at which you have arrived. I agree that the first evidence that a water-supply has been polluted may be found in the breaking out of sickness among those who drink the water; that chemical analysis is not always or invariably able to detect impurities in water, which may be sufficient to produce sickness; and that the only course consistent with securing absolute safety to health is to so guard the sources of water-supply, that no contamination of the water can possibly take place.

I desire, as you will observe, to state this admission in the strongest possible terms, so that my learned friend, who represents the petitioners, will not be able to claim, on this subject of the necessity of securing a supply of pure water, any thing which I am not ready to concede. At the same time, I may be permitted to remind you, that, although sickness from a community supplied from a given source of water is sometimes the first positive evidence of pollution; yet when that sickness occurs, and its character is established, there is generally no difficulty in tracing the source of pollution; that, with proper care and observation on the part of the health authorities, the existence of that source of pollution would have been known long before the effect was produced, and, when known, would have led to adequate remedial measures; and finally, that because impurity in water sufficient to cause disease, although undiscoverable by chemical analysis, *may* exist, it does not follow that it is *likely* to exist.

The *danger* of the *possibility* of such impurity is to be determined, in each case, by the facts of the case. In each case to which the attention of the scientific investigator is called, he has given the area, depth, and capacity of the water-supply, the character of the surrounding territory, the density of population, the uses to which the soil is put, whether to farming, to manufacturing or other establishments, or dwellings, the sewerage and tendency of surface drainage, whether to or from the source of supply, and many other facts in the nature of detail, which each case will supply.

Given these facts, he knows beforehand what is the possible source of impurity, what the nature of the impurities possible to be communicated to the water, and what the resources of chemistry to detect them. He may conclude that, in a given case, a competent chemist would be able to determine conclusively the quality of the water. In another case, he may decide that the removal or careful regulation of a particular trade, or the proper disposition of the sewage of a certain village or street, would obviate all danger. Each and every case must be passed upon, on its own facts. In each and every case, those clothed with authority and called upon to act, must exercise their common sense in deciding what should be done, and what let alone. So in this case, while I go as far as any citizen of Cambridge can go, in insisting that every precaution should be taken to guard against any danger of injury to the waters of Fresh Pond, I yet insist that this case should be tried on its facts, and that at least some reasonable ground of apprehension of danger should be established, before the Board should be asked to intervene. Before proceeding, however, to the discussion of the facts, as shown by the evidence, I desire to call the attention of the Board to the intent and purpose of the statute of 1871, chap. 167, under the provisions of which this Board is asked to proceed. I will not read the statute,[1] because you all know it by heart. Suffice it to say, that the first section provides for the licensing by the local board of health of certain places, for the carrying on of certain trades; while the second section empowers the State Board of Health to prohibit the carrying on of the same classes of trades, "if, in their judgment, the public health, or the public comfort and convenience, shall require:" in other words, the first section authorizes local boards of health to establish and legalize certain trades in certain localities; the second section apparently authorizes this Board to suppress and discontinue the carrying on of these trades, perhaps the very day after their establishment and legalization. For it is very evident, if the position indicated by the learned counsel in his opening be tenable, — to wit, that it would be a sufficient ground to warrant an order of prohibition to a respondent in one of these cases, to show that he had selected an improper place to carry on his trade, — that then the selectmen of Belmont might assign a portion of their town, for the carrying on of certain trades, and might give especial permission in writing, to these respondents, to erect their building and carry on their trade within the assigned limits; and yet the State Board of Health, if in their opinion the place were not suitable, might the very next day, or at any stage of the erection of the buildings, order the same respondents to "cease and desist" from carrying on their business on the premises. The Legislature surely could not have intended in the same statute to confer upon one board a power to authorize and legalize the carrying on of a trade at a specified place, and on another board the power to prohibit, upon the very next day, the carrying on of that very identical trade, at that identical place. Some reasonable limit must be placed upon the language of the second section,

[1] See pp. vii and viii.

to make it reasonably consistent with the first, for both must be construed so as to harmonize if possible.

What, then, is the true construction? Let me observe in passing, that I do not now desire to enforce by argument the position taken in the protest, filed by my clients, to the jurisdiction of your Board. That was filed to save legal rights, and because, in view of the decisions of the Supreme Judicial Court in the Sawyer case, it seemed to me that I ought not to overlook the fact, that those decisions pointed to the existence of a concurrent jurisdiction on the part of the town boards of health, and the State Board of Health, over this whole subject of the permission and prohibition of certain trades; and in this particular case it seemed to me worthy of consideration, whether or not the selectmen, acting as the Board of Health of Belmont, having jurisdiction of the subject matter, and having exercised that jurisdiction, and granted permission to my clients to erect their buildings and carry on their trade, were not the proper tribunal to which to apply, in case the establishment authorized by them became a source of offence. This question, however, is disposed of, so far as the present hearing is concerned, by the decision of your Board to go on with it; and the only matter open to us is the question just now stated: What is the true construction of sect. 2 of the Act of 1871, that is, the construction that will make it consistent with the first section of the same act?

A town board of health have been applied to for permission to erect a slaughter-house. They have heard the petitioners and all remonstrants, who upon sufficient notice have appeared before them. They have examined the premises, and have ascertained the views and feelings of the inhabitants who would in their persons or estates be affected by the granting of the petition. They give the permission required by the statute, and the buildings are erected conformably to their permission. No one claims that the buildings or the business are a nuisance. No one doubts that the selectmen have acted within the scope of their authority, in accordance with their sound judgment, and with the approbation of a majority of their townsmen, in whose behalf and for whose protection the statute of 1871, the chap. 26 of the General Statutes, and all antecedent statutes upon the subject matter, were enacted.

Has a case arisen for the interference of the State Board of Health before the business is started?

Has a case arisen before it can be determined what the effect of the business will be upon the neighborhood?

The true construction of the act would seem to be, that the permission given by the local board of health, to carry on the trade, should be deemed to authorize or legalize its carrying on, unless and until facts should be presented to the State Board of Health, sufficient to warrant them in coming to the conclusion that the business could no longer be carried on, at that place, without injury to the public health, or at least to the public comfort.

But I shall be told that there is no such limitation upon the powers of the State Board of Health, contained in the "second" section of the act. One answer to that suggestion has already been stated; to wit, that the

"first" and "second" sections of the act must be read together. But there is an express limitation, contained in the requirement of the statute, that your judgment should be satisfied that the public health or public convenience demand your interference.

True, the Legislature reposed entire confidence in your *judgment*. In the original constitution of your Board, it was not intended that you should exercise any judicial function. But when the time arrived that called for some active exertion of the power of the State, to control and regulate the exercise of certain necessary but unnecessarily offensive trades in the vicinity of a metropolitan city, the Legislature wisely selected your Board as a safe, impartial tribunal, composed of sincere and disinterested men, experienced in diseases, and solicitous to ascertain their causes and the proper mode of their prevention, as a safe depository, within the area of six miles from the City Hall, of some of the powers heretofore exercised by the local boards of health.[1] By subsequent statutes, — that of 1871, chap. 176, and of 1874, chap. 308, — these powers were extended, so as to embrace all the cities and towns in the Commonwealth.

These facts simply show what confidence the Legislature reposed in your integrity and your discretion. The greater the powers conferred upon you, the greater the responsibility you assume in the exercise of those powers. If no special restrictions were placed around the broad authority given your Board by section second of the Act of 1871, it was because, in the first place, such restrictions might hamper your action, and, in the second place, the Legislature felt assured that, in the exercise of the powers conferred upon you, you would carefully observe the rights of citizens, would ascertain and pay regard to the action of the local board of health, and would assume and employ the almost arbitrary authority given to you, only upon proof that an emergency existed which justified a resort to extreme and summary processes.

Has such an emergency been proved to exist in this case? Have any facts been shown or suggested, that would justify any man in saying, that, in his judgment, either the public health or the public convenience or both combined require that these respondents should forthwith, before they have fairly begun to do business, be ordered to "cease and desist," from carrying it on?

We know what reasons are given usually in these cases, for believing that the public health is endangered, and the public convenience interfered with. A trade may be so noxious as to contaminate the air; it may create substances which pollute the water; it may be so located as, while not actually injurious to health, yet to cause great annoyance to the neighborhood and public, and actual loss of value to the property near by it.

The last-mentioned element is out of this case. There are substantially no neighbors, and there is no complaint from property-holders.

In fact, it appears to be the general opinion, that the establishment has added much to the taxable value of the real estate of the town. So

[1] See statutes of 1870, chap. 365.

far as the public convenience is concerned, this location would seem to be an eminently fit one.

Some slight evidence was introduced that on certain occasions unpleasant smells had been detected in the neighborhood of the building, but the cause of these was explained. They resulted from the accidents to the pipes and dryer, which accidents for a short time disabled the respondents from disposing of their products as rapidly as usual, and caused them some trouble. But ample precautions have been taken to prevent a recurrence of accidents; and, as the Board are fully aware, all danger of offence from bad odors is obviated by the arrangements now made, and tested by experiment, for burning the gases in the furnaces, for rendering and drying all blood and animal matter, and carrying away from the premises all refuse liquid products of the business.

There remains simply the apprehension that at some future time some danger of the pollution of the water of Fresh Pond may arise.

To justify this apprehension, the only arguments employed are, —

First, That water may be polluted by impure matter, which percolates through the adjoining soil.

Second, That such impure matter may soak from the slaughter-house into the ground, and so reach the conduit or the pond.

Third, That the drainage is insufficient, and the products of washing, rendering, and drying, not utilized in the building, will not be carried off

Fourth, That the "soup" deposited upon the muck-beds at the top of the neighboring hill will in some way soak into the soil.

No proof has been offered of any one of these propositions, except the first; and that, as a general proposition, no one disputes. If any thing is clear in this case, it is, —

First, That no pollution of the water of Fresh Pond has yet taken place by reason of the building and use of this establishment.

Second, That there is not now any danger of any such pollution.

Third, That with proper care on the part of the proprietors, and proper supervision on the part of the health authorities, there never will be any such danger.

There remains only the apprehension of the good people of Cambridge, which, proceeding from want of knowledge on their part, can only be allayed, when sufficient information of the actual facts and possibilities may reach them.

First, No impure matter can soak from the slaughter-house into the ground. I will not, at this moment, presume to discuss the character of soil around the buildings, whether pervious or impervious to water. I take the only position that your Board, and my clients as well, ought to take, that the buildings must be so constructed that no washings or liquids of any kind can soak into the ground, or get upon the ground from the buildings. This construction has been adopted, and the proof of it is before you. Not a particle of testimony has been offered to raise a doubt on this point, unless the accidents to the drain, and "soup" pipes may be supposed to have some bearing.

But it is not from the result of a temporary accident that the soil

becomes impregnated with impurities beyond its capacity to absorb, or otherwise take care of.

Pollution of water by impure matters results, as Professor Nichols says in substance, from a continuous deposit of impure matter, or of substances which become decomposed, upon or in the soil. In the cases of the accidents referred to, the soil was not probably so much as moistened more than three feet in depth, if so much, and over a very small area superficially. Any one who has tried the experiment of watering a flower-border will remember that a very large amount of water is needed to wet three inches in depth below the surface.

But it is said the drainage is not sufficient. By this is meant that Alewife Brook is not a proper receptacle for the water carried into it by our three-inch pipe; that the brook will not carry off the washings of the slaughter-house.

This objection comes with peculiar emphasis from the city of Cambridge, which pours into that same brook, every day, at least one million five hundred thousand (1,500,000) gallons of sewage from the mouths of three sewers, which together taket he drainage of acres of land, some portion of it already, and nearly all of it to be, covered with dwelling-houses, their stables and outbuildings.

So long as Cambridge uses Alewife Brook as an open sewer, the contribution of matter almost entirely water, added from this establishment, is too small to be appreciated.

If the city should, in time, build a closed sewer alongside of the brook, our drain could open into it, and the question of the brook could finally be settled for Cambridge and for us at the same time.

As to the three-inch drain-pipe, the testimony is that it is sufficient for our purpose, and the head obtained (of twelve to fourteen feet) by pumping the water up into the floor over the basement is amply sufficient to carry off every thing without applying pressure. Even if pressure were to be employed, the pipe, as now laid, is believed to be strong enough to withstand the force. If thought desirable by your Board, it is only a question of expense to lay the pipe alongside the brook to a point below the Fitchburg Branch, formerly the Lexington and Arlington Branch, where a gate could be put in, so that nothing emptied into the brook could be floated back above the railroad embankment.

The only other supposed ground of apprehension that something may soak into the ground arises from the proposed method of utilizing the "soup" liquid, by mixing it with muck.

The experiment of delivering the "soup" upon the muck-beds, after some little difficulty from an irregular location of the pipes, has now, since the pipes were straightened and raised above the ground and over the conduit, resulted in success. The only question remaining for solution, and one that can only be determined by actual experiment, relates to the capacity of the muck to absorb the liquid.

I do not understand Professor Sharples or Professor Nichols to disagree upon this, that the quantity of muck already upon the ground will take care of very large quantities of the "soup." It will be a long time

before the muck will be saturated so that any thing could permeate even the top soil of the hill; and the soil of the hill could have the "soup" poured directly upon its surface for a very long time, perhaps many months, or even years, before any dangerous product of decomposition could set out on its way to the pond. But it is not the intention, as it clearly is not for the interest, of my clients, to allow any of the "soup" to reach the surface of the hill. They expect a ready market for the valuable product of the muck, after being treated with the "soup," and have abundant facilities for keeping up a supply of fresh muck and loam as often as wanted.

In view of the opinion expressed by the chemists, it is reasonable that the experiment should have a fair trial, since such trial can injure no one.

If from any cause it proves unsatisfactory to your Board, the Messrs. Niles have every facility for running the "soup" into tight wagons, and carting it off while fresh.

Much discussion has taken place, during the progress of this hearing, in regard to the character of the soil between the buildings and the pond or the conduit.

For reasons already stated, I do not think it is at all important to what conclusion the testimony on the subject points. Indeed, I doubt if you can arrive at any satisfactory conclusion at all. A safe course is not to give the soil, however composed, a chance to be the vehicle of mischief. It can only become so by long-continued carelessness on the part of the occupants of the building. Such carelessness will be detected and stopped by your Board, long before it can result in injury. Moreover, the proprietors have shown every disposition to guard against the effects of carelessness or accident. It is admitted by the witnesses for the petitioners, that, on the occasion of the leakage of the pipes, immediate and effective measures were taken to repair and make perfect the joints.

They sought the best advice on the mode of constructing their works at the outset, and have begged the city authorities and their expert agents to make any suggestion, the adoption of which, in their judgment, would furnish any additional security against accident. How their request has been met, has been fully shown by the evidence, and I need not comment upon it.

All we can say upon the subject of the character of the soil would seem to be that upon the hill there appear to be strata of gravel, clay, and gravel again. Around the slaughter-house, the clay crops out or is found near the surface at many points between the buildings and the conduit. Some observations indicate that the strata of clay descend quite steeply from the surface at the last-mentioned locality. The conduit itself, after it leaves the gate, appears to have been laid much of the way upon a clay bed, which seems to separate the swamp from the upland. If this clay forms an impervious dike, it tends to justify the opinion, expressed by the city engineer, that the water in the conduit comes from the gravelly land on its north or north-west side, and not from the swamp on the southerly or south-east side. It lends plausi-

bility, also, to the opinion that the clay dike extends between the conduit and the buildings; an opinion that gains strength also, from the well-established fact, that, when the pond in the rear of the hog-house was pumped out, there was no appearance of water coming in from the conduit. On the contrary, when the pond refilled, the water for the most part came in from the side of the pond most remote from, and opposite to, the conduit. On the land between the large building and the pond is found a hard-pan, at a varying depth. It does not appear whether a stratum of gravel covers the "hard-pan" everywhere or to any great extent.

In digging for the foundations of the building, this "hard-pan" is met with, and indeed a part of the surface soil, under the hanging-rooms, is of that material. Wherever this "hard-pan" is found, it is a barrier to the flow of the water.

A puddle bank formed of the materials found in abundance upon these premises could be made, if ever needed, by the construction of which an impervious dam could be formed on all sides of the buildings. On this point, I read from a paper in the seventh report of the American Society of Civil Engineers, by W. J. McAlpine, whose eminence in the direction of water engineering is well known. My quotations are from pp. 65, 66, and 72. I will leave the document with the Board.

"The first coffer-dam at the United States Dry Dock gave way, chiefly because it was filled with clay. The one built by the author withstood a greater pressure, because it was filled with gravel. . . . An embankment of gravel is comparatively safe, and becomes tighter every day. . . . The weight of thirty feet in height of gravel had so compressed the sand as to make it impervious to the lake water under twenty feet head. . . . The substitution of gravel for clay to resist the escape of water in dangerous places." [Spoken of as his experience, and worth bringing before the profession.]

You will observe that there is between the house for keeping live hogs, and the conduit, a railroad-bed. I suppose it will be conceded that the bed itself, and the soil under it for a great depth, become packed very solid so as to make a dike impervious to water. The evidence offered as to the course of the water-currents below the surface is quite limited. The only well-defined current would seem to be from the conduit, south-westerly along the slope of the hill.

The surface-levels taken all over the marsh, and at and near the slaughter-house, indicate a fall all the way from the conduit and buildings toward Alewife Brook; following the general rule that the tendency of water is towards the water-courses that will conduct it towards the sea. No great stress is laid upon this general rule. We simply say that we find here what we should expect to find in the absence of disturbing causes. We may have some ground to infer also the existence of a water summit, so to speak, following very nearly the line of the conduit on its south-easterly side.

As bearing upon various propositions which I have stated to the Board, I propose to cite from some official documents of the City of Cambridge. I will leave copies of the documents.

1. A communication from William S. Barbour, City Engineer, to the City Government, dated Sept. 28, 1877, pp. 6, 10.

. . . "Fresh Pond Hotel, the arrangements of which are good, and if proper care be taken of them, and the vaults not allowed to overflow, need cause no alarm. The house-drainage is delivered on a cultivated field at some little distance from the pond. The whole should be carefully watched, and proper care insisted on.

"The next is Alewife Brook, the natural outlet from Fresh Pond, as well as Little and Spy Ponds. There are at present emptying into this brook, three large main sewers, as follows: Concord-avenue, intended as an outlet of the proposed marginal sewer around Fresh Pond, with a drainage area of 298.21 acres; Spruce-street, with a drainage area of 382.93 acres; and North-avenue, with 183.64 acres; the North-avenue and Spruce-street sewers draining each, for a portion of their areas, quite closely populated districts, — Concord-avenue entering it at a point about four hundred feet distant from the pond, the drainage backing into the gate-house on the border of the pond, and kept out from it by a single gate of plank. When the water in the pond is below the level of the brook, as it has been for a considerable portion of the time for several years, any accident happening to the gate causing a leakage, or its removal, would cause a discharge of sewage into it which it might be impossible to remove. With a very small outlay, this might be made secure from danger. Just beyond North Avenue, the brook also receives the drainage of the tanneries of William Muller and Ferdinand Fischer, both large establishments, all the drainage of which is poured into the brook, and may be seen at the tide-gates on Broadway in considerable quantities, and has been removed at this point for a number of months, as often as once a week.

"For Wellington Brook the sewage should be brought down in a pipe, or the brook abandoned to sewage, and the water brought in a pipe. For the sewage, a small pipe would answer, if it were used only for the present and likely sources of pollution, and not for the main for town drainage. If this water is to be used, I urge the importance of the sources of pollution before named receiving immediate attention. But to return to Strawberry Hill. It is important, that, before the fall and spring rains occur, something should be done at this point; and I would suggest, that, if suitable arrangements can be made with the owners, the water be pumped over the intervening hill through a pipe to Bird's Pond. An eight-inch Blake or Knowles pump, with three or four-inch discharge-pipe, would, I think, remove all the accumulation to a point where it could not overflow into Fresh Pond. . . . The great amount of vegetation and the numerous pond-lilies growing in Bird's Pond would, I think, effectually prevent any nuisance being caused therefrom. If this plan should meet with favor from your committee, I would suggest that a further and more careful examination be made, with a view to carrying it out."

2. Twelfth Annual Report of Cambridge Water Board, pp. 18–21, 27–29.

"Tables showing the analysis of the water at the time it was taken for the use of the city, and at various times since, down to a recent date, . . . show that the water of Fresh Pond has nearly maintained its original standard, as per Mr. Sharples's Table No. II., attached to this report. . . .

"The only places from which your Committee think that there is immediate danger to Fresh Pond are on the south-westerly side, near Cushing Street, where more or less drainage, at certain seasons of the year, finds its way into the pond, and should be cared for at once; also from the drainage which may find its way into the pond from Fresh Pond Hotel, and the picnic-grounds and the boating connected therewith. . . .

"Analysis shows that the amount of pollution which finds its way into [Wellington Brook] from this source [pig-pens] is more imaginary than real: still we think that arrangements should be made with the owners, either to remove the pens entirely, or, if that cannot be done, to change their location, so that all the wash or surface-drainage would run southerly, and away from the brook; and that a tight cement cistern be built to catch and hold the drainage.

"Perhaps it is a misfortune that our water-supply is too near home, and is subject to the personal observation of our citizens from day to day. This is probably the reason we hear complaints. Persons see and report what in itself is impure, not thinking of the process of purification that takes place before the water they see is used.

"Numerous determinations [of Lake Cochituate] made by Professor Nichols show that the water, as delivered in Boston, is better than when it left the lake. . . . In fact, Nature understands her business, and, if we only give her time enough, will take care of all noxious organic matters in water. It is only when such matters are taken fresh into the system that danger is to be apprehended. . . . Now, since the conduit enters into Fresh Pond comparatively near the surface, and at a distance of over half a mile from the inlet-pipe to the water-works (which is at least twelve feet below high-water mark), and discharges into a body of water sufficient for nearly two years' supply for the whole city, it would be probably many months from the time its water entered the pond before it was taken out. . . .

"To show the rapid manner in which sewage is eliminated from water, I give some quotations from eminent English authorities. Dr. Frankland says, in 1867, in 'The Quarterly Journal of Science,' 'The population in the basin of the Thames above where water is taken is 1,000,000, the drainage of some 600,000 of whom is poured into the river. This sewage is so thoroughly oxidized, that no trace of it can be detected in an un-oxidized state. The average flow where the companies take their supply is 800,000,000 gallons daily; the sewage contained would be $\frac{2250}{1000000}$.' Dr. Letheby states, 'I have arrived at a very decided conclusion, that sewage, when it is mixed with twenty times its volume of running water, and has flowed a distance of ten or twelve miles, is absolutely destroyed; the agents of destruction being infusorial animals, aquatic plants and fish, and chemical oxidation.' The Royal Commission on the water-supply of London says in 1869, 'But though, for these reasons, we believe that the organic contamination of the Thames is much less than is commonly imagined, still it would be sufficient to do great mischief, were it not for a most beneficial provision of Nature for effecting spontaneously the purification of the streams. Some of the noxious matter is removed by fish and other animal life; and a further quantity is absorbed by the growth of aquatic vegetation: but, in addition to these abstractions, important changes are effected by chemical action. . . . This purification process is not a mere theoretical speculation. We have abundant practical evidence of its real action in the Thames and other rivers.'"

3. Report of Professor Sharples to Water Board, Thirteenth Annual Report, pp. 6-22.

"The greatest source of pollution to our water now by drainage into the pond is from the Cushing-street district in Belmont. This at times is very bad, and is growing worse every year. In times of heavy rains, a large amount of very objectionable matter flows into the pond, over the low lands bordering on the pond on the south-west side. We think this subject has assumed such proportions that there is no justification for any longer delay in providing a remedy; and if this is not done our citizens will have just ground of complaint.

"At Wellington Brook gate-house, a tight wooden flume, thirty-three feet in

length and four feet in width, having a gate at its upper end, has been built to secure a clean channel from the brook to the conduit, when water from this source is used. The open channel which before existed received deposits of solid matter from the stream, without means to prevent their discharge into the conduit. The sides of the Wellington Brook channel proper, at its crossing the conduit, have also been faced with sheet-piling for a length of fifty-six feet, and a gate set at the up-stream end. Much has been done this year to relieve the brook above the conduit from agencies of contamination on its borders. The most polluting influences have been abated, and others should receive future attention. Its waters should be taken early in the spring or late in the fall. No necessity to use them has yet occurred at any other season."

4. Report of last year, published January, 1878, pp. 9, 10.

"The Water Board report that much attention has been paid the past year to removing any sources of pollution of our water-supply. At Richardson's piggery, of which so much has been said, the lower pens, which drained towards the brook, have been removed, the ditch leading to the brook has been filled up, and a dike thrown up at the foot of the uplands on the edge of the meadow. This, in their judgment, will prevent any drainage finding its way into Wellington Brook from this source. The Board recommend the construction of a sewer . . . for the purpose of taking the drainage . . . which now finds its way into Fresh Pond."

Dr. Cogswell's paper in your last report is familiar to you. I spare any lengthy comments on these quotations. Richardson's piggery, long time the subject of complaint, becomes harmless by removing the pens away from Wellington Brook, and that becomes a sufficiently pure stream. The great quantity of water in Fresh Pond renders innocuous all the drainage from acres upon acres of highly tilled land, soaked with the most high-toned manures, and covered, no doubt, every fall, with heaps upon heaps of decomposing vegetable matter, not worth carting to the market. Its purity is not yet seriously affected by the drainage of the Cushing-street district, or the contributions of the tens of thousands of picnickers, who day after day, in the summer months, congregate at the Fresh Pond House. The water clears itself of all this pollution, except so far as filtration through the soil has already purified it. These reports, and another which I hold in my hand, and of which the Board has a copy, do show, undoubtedly, that there has been apprehension for many years, in the minds of the people of Cambridge, in regard to the quality, now or in the future, of Fresh Pond water. This apprehension has led to many schemes for preserving its purity, but I do not understand that any really efficient scheme has been operated upon; at least, I cannot find any thing has been done, except to make plans and speeches. But now, no sooner does a barrel of dirty water escape, through a leakage of a pipe, into the embankment of the Fitchburg Railroad, than that great and wealthy city — too wealthy, we are told, to make it wise for us to contend against them — transfers its apprehensions to this slaughter-house, and hastens, with nothing but this new turn of apprehension to support its claim, to apply to your Board for summary action against these respondents. The party of annexation, and the party of purchase of lands around the pond, the believers in an intercepting sewer around it, and in new sewers from the region of the pond to the sea, all disappear from

sight; and the city authorities with their able counsel come before you, and ask you to say, not only without evidence, but in the teeth of evidence to the contrary, that here is a case where your judgment is satisfied, — the judgment of a Board of learned and scientific men, of sound-minded men of affairs, of lawyers and of students, is satisfied that the public health and the public convenience require that the Messrs. Niles should now, at once, instantly, cease and desist from carrying on their business.

Some reference has been made on the other side, to former decisions of your Board, in cases where offensive trades have been proved to exist. These cases were not like this. They were cases where immediate offence and danger existed; yet whenever time was asked to remedy the evil, and a practical remedy was found, the Board took pains to regulate and control the business, and defer the order to cease and desist, in such a manner and for such a time as could cause the least loss and injury to the business of the respondents. In this case there is no disposition on our part to do any thing that may conflict with such reasonable regulations as we know you would prescribe. Instead of buildings such as were formerly used, which were almost incapable of improvement, we show you buildings constructed in conformity with the best models. Instead of running the refuse into an open pond, we remove it beyond the reach of harm by a sufficient drainage.

In any appeal to your discretion, the situations of the parties, and the consequences to each, are to be taken into account.

The city cannot suffer by your refusal to act at this time; still less, if you decide to act in the way of supervision and regulation. On the contrary, the respondents, if you issue the order as prayed for, must at once suspend their business, and suffer irreparable loss and injury. If they appeal, it will be years before their appeal may be decided. Pending the appeal they cannot do business; and, whatever the final decision, they are seriously crippled while waiting. Between thirty thousand and forty thousand dollars are already invested in the buildings, to say nothing of the amounts involved in contracts and purchases made for carrying on the business.

The power to regulate this business, in any case where your Board can prohibit, is expressly found by the Supreme Court, and results from the statute of 1871, construed by the light of General Statutes, chap. 26, sect. 52, § *seq*. That power to regulate, we say, is the power that should now be exercised. We should cheerfully comply with your requirements. As you are aware, we are availing ourselves of the best scientific skill in the conduct of our business, that can be attained in this State. With the aid of such supervision as your Board might make (and I hold with Professor Nichols that such supervision is always advisable), we feel entire confidence, not only that no injury will ever accrue to the people of Cambridge from this business, but that in a very short time even their fears will be allayed. These apprehensions will then, operating in the right direction, stimulate them not only to devise, but to carry to a practical result, some effective plan for preserving the purity of Fresh Pond from the sources of pollution which are already operating, and which give reasonable cause for anxiety in the future.

Mr. Chairman and gentlemen, I thank you for your patient attention.

MR. HAMMOND'S CLOSING ARGUMENT.[1]

MR. CHAIRMAN, AND GENTLEMEN OF THE BOARD, — I feel the same embarrassment in the discussion of this matter which my brother Warren has expressed. I am aware that we are discussing it before a board that knows more about it than we do, and may therefore be somewhat impatient in listening; but the consequences of this hearing are such that I feel I ought to say a few words. Perhaps neither my brother nor myself takes the right view of the importance of the consequences which will come to our respective clients by your decision. Certainly the consequences to the city seem to me most momentous. On this subject I feel strongly, and must express myself strongly. I concede that in the matter of the condition of the slaughter-houses of Brighton, some years ago, to which I alluded in my opening remarks, upon which my brother has commented, my experience is not equal to his.

But I did not describe their condition as he remembered them, nor as I remember them. I read from the book; from the condition of those slaughter-houses as detailed by this very Board in its various reports; and I say now, as I said then, that you have come substantially to the same point with regard to this hog-slaughtering business that you came to when you dealt with the butchers in Brighton.

Now, what, for instance, was the fault with the proposition made to you by those butchers? They offered to make many improvements; and, in their own language, these improvements "comprise the laying of tight floors of materials impervious to moisture, and the giving of these floors the required inclination to shed the blood, water, and other matters into suitable vessels provided for their reception, and daily removal from the premises. The vessels will be made of material impervious to moisture and kept perfectly clean and sweet. . . . The greater or lesser quantities of putrescent matters which may have been suffered to accumulate upon their premises will be deodorized, and their putrefaction arrested by means of the agents above named, and covering them with peat or charcoal or other material, in case these should lack sufficiency. During the coming winter, these accumulations shall be removed, after incorporation with enough deodorizing material for the complete removal of their offensive odors in the process of handling."

These propositions were not satisfactory to this Board. And to the plan of the respondents in this case, we make the same answer which you made to the similar plan of the Brighton butchers. It is not satisfactory. It is lacking in that most essential requisite, — complete drainage.

My brother in this connection makes a most extraordinary statement. He says his clients in this case are humble and penitent, while the Brighton butchers at first were defiant; and he presumes that this Board will deal differently with men who, at first defiant, afterwards went upon their knees, and offered to do what they thought they ought to do, than

[1] A report of this was published also in one of the Cambridge papers.

with his clients who have never been defiant. His statement, implyi as it does that this Board of Health, a board of public officers invest with judicial powers of great magnitude, will in the exercise of tho powers be influenced by motives akin to revenge, contains in it a censu upon the Board (although without doubt not so intended by my brother which needs no answer at my hands. You will deal with matters as yo find them with reference to their sanitary aspect; and the attitude of persons interested, whether defiant or humble, will not influence you. I do not intend to follow further the remarks of the learned counsel. His views and mine are so different that they hardly touch. What is the case which you have before you?

A great pond of two hundred acres in extent has been set apart by the Commonwealth, for the purpose of supplying the inhabitants of our city — fifty thousand in number — with pure water. A conduit connects that pond with another pond in this direction [pointing to the map]. Through this conduit runs water from the neighboring soil. The people of Cambridge, in reliance upon this grant, have expended more than sixteen hundred thousand dollars in pipes, &c., for collecting and distributing the water through the city. The inhabitants have adjusted themselves to this state of things, and there are substantially no wells in Cambridge. We rely entirely upon this water. Not only that, but it is a fact known to you all, that the ice from Fresh Pond is the purest in the market. It is distributed by wagons into the houses of all, and may reach your home and mine. It is shipped to foreign countries; and in view of all this, it is not too much to say that the consequences of your decision in this matter are world-wide in extent.

Talk of smells and odors being offensive and injurious! They are common to all these establishments. We have them here; and on this account alone this slaughter-house is a nuisance, and must always be. They say it is in an unfrequented place. On the contrary, it is upon one of the most frequented highways leading out of Cambridge, an avenue leading to the beautiful town of Belmont, which has been called by some one a town "composed entirely of gentlemen."

Now I say that on the side of the public, here you have not only the ordinary features of offensive and injurious odors, but you have an extraordinary feature, — the interest of the public in the purity of the water of Fresh Pond and the ice which comes therefrom.

What have you upon the other side? You have a slaughter-house, and to this Board of Health that expresses the whole. A business which is tolerated only because it is necessary, — a business which we would have swept away from the face of the earth if we could. Like the water-closet in our houses, and like other similar things demanded by the wants of our existence, they are tolerated only because they are a necessity. All society desires to get rid of them. For more than two hundred years they have been recognized in statute-books as establishments to be put out of the way, in unfrequented localities. Where is this slaughter-house put? It is put right there [pointing on the map], wl it has communication with the soil of the whole neighborhood: within a few feet of our conduit into which the waters of that a

and through that into Fresh Pond. The consequences of any pollution are terrible.

Now what do we ask you to do in this matter?

Well, what have you the power to do? Under the statute of 1871, you may prohibit the slaughtering in that building, or you may regulate it, as you choose. Your decision is not final, and whatever order you make may, on appeal, be passed upon by a jury. Yet your decision is that of a board of officers higher than any local board, and it is necessary to come to you, on account of the various influences which affect local boards. This Board, I venture to say, would never have licensed that slaughter-house in that spot; and while I have nothing to say against the selectmen of Belmont, and am bound to presume that in their decision they discharged their duty according to their conscience, yet there is no doubt, that, had Belmont had water-pipes running from Fresh Pond, the public opinion of the citizens of that town would have compelled those selectmen to have refused the license. It is because of these local influences that we come to you.

And now what do we ask you to do? We ask you to meet the situation, and to make the same reply to these respondents that in 1871 you made to the sixteen butchers of Brighton: "Your tight floors impervious to moisture, your hills for disposing of the 'soup,' your whole proposition, is, in fact, unsatisfactory to us, because, among other reasons, you have no proper means of drainage. You do not go as this Board of Health thinks a slaughter-house should go, — by strong currents to deep tidal water; but instead thereof you go by a three-inch pipe half a mile long to an open ditch." A more ludicrous burlesque upon the required drainage could never have been planned, than the method which these respondents have adopted. We believe that this Board should go further, and, as the general supervisory Board of Health of the Commonwealth, should lay it down as a rule, and from this State House proclaim it in unmistakable language, for the guidance of all local boards and the whole people, that, in consideration of the dangerous consequences likely to arise from the negligent management of a slaughter-house situated near the source of water-supply of a city, we will never consent to the existence of such a building thus situated.

No law is more uncertain than that which rests alone in the breast of the judge. Laws are rules of action; and the administration of law should proceed upon rules as far as possible, — upon rules easily stated, easily understood, and easily applied. In the language of the statute establishing this Board, you take "cognizance of the interests of the health and life of the citizens of this Commonwealth." You represent the advance-guard upon these subjects; and this rule should be adopted by you, so that all local boards of health should understand it. You have the right to adopt such a rule, and it is in accordance with the whole course of legislation upon this subject. In the year 1692, was passed a law giving to local boards of health the right to assign limits within which slaughtering might be carried on, and prohibiting the exercise of that trade outside of such limits. Ever since then, substantially the same law has been in force in this Commonwealth, and is in force

here to-day. The local board of Belmont has that power within the limits of the town — as the local board of Cambridge has, within its limits, and you have it as well. There is no doubt about your power to adopt this rule of action.

I say it is the only just rule you can apply. Whether this slaughter-house endangers the purity of the water of Fresh Pond, or not, one thing is certain: the people who use the water, the people who use the ice, *think* it may, — think the slaughter-house is *dangerous* there. And I say that this very fact is a legitimate matter for you to consider in this connection. If these offensive trades are to be assigned territorial limits, they should be located where they can do the least harm; not where by their very existence, whether actually injurious or not, they of necessity must unfavorably and seriously affect great and important rights both public and private. Now, if the people who use this ice get the notion that the slaughter-house is dangerous, the trade of the ice-dealer is gone, whether the notion be correct or not; and in the same manner, the material prosperity of the city is affected, whose inhabitants use the water. Mr. Chairman, is it necessary for me to say that, if it is generally believed that the water-supply of the city of Cambridge is in danger, the material prosperity of the city is seriously injured, whether that belief be well founded or not? A person will not carry his family, the dearest to him of all earthly objects, to drink water that he fears may be so contaminated as to injure health. In considering, therefore, what limits shall be assigned to these offensive trades, I say you may properly take into account these facts, and that it is not just unnecessarily to jeopardize such great interests by fixing a location so near to a source of water and ice supply.

But I ask you to adopt this rule because, finally, it is the only safe rule. My brother Warren says here that we "can't show that that slaughter-house pollutes the water." No, and we never shall show it; and, long before it can be shown by the lips of living witnesses here, it will be recorded in the graveyard. The tombstones will contain the first record of that evidence. It is an established principle of sanitary science, that drinking-water may be so polluted as to cause disease and death, and yet pollution not be detected by the most minute chemical examination, nor by any other way known to man except through its deadly effect upon the human system. That being conceded, I say that the rule I contend for is the only safe rule.

Of what use is it for the respondents to tell us, "We shall not hurt this water at present: we may possibly in the future; and, when we do, you can find it out, and stop us"? Are you, as the representatives of the public interests, and the persons officially intrusted with the duty of taking cognizance of the interests of health and life among the citizens of this Commonwealth, — are you going to wait until it can be proved to you that that slaughter-house pollutes that pond?

Such a course is not safe. I repeat, it is not safe, Mr. Chairman and gentlemen. In the ordinary business of life we do not act on any such principle as that. There are some risks too hazardous to be taken. There are some things so dear to us, and so important, that possibility

of injury to them is sufficient to deter us from running the risk. Would you allow your child to play among dangerous and unprotected machinery? He tells you he will be careful. Perhaps in ninety-nine times out of a hundred he would escape injury: yet the consequences of any disaster are so great, you will not allow him there. If you were managing a railroad, would you employ an engineer who tasted of intoxicating drinks? If you did, you would be derelict in your duty to the public.

The law says that no guardian or trustee shall buy, as an individual, that which he sells in his fiduciary capacity. No matter how high a price he pays, or how fair the transaction, the court will at once, upon the suggestion of the person interested in the property, annul the sale. The court will not inquire whether in that particular case any injury has been, or is likely to be, sustained: they have made a general rule that they will not allow such transactions.

The effect of this slaughter-house upon the water of this pond reminds one of the midnight assassin. His approach unheralded and his presence unknown, he gives the fatal blow to an unsuspecting victim, and death succeeds sleep, no conscious moment intervening. I say the risk should not be run, and that safety demands the establishment of the rule we ask.

There is danger shown here in this case, upon the evidence. You must feel satisfied, I think, on this evidence, taken in connection with what you know, that the tendency of the ground-water in that vicinity is toward the pond. Mr. Barbour's experiments show, at any rate, that the tendency of the water is across the conduit, and that the water from the conduit goes into the pond. It is the same as if the slaughter-house were within fifty feet of the pond.

Now, in explanation of the disagreeable odor, and the obnoxious leaking of their drain-pipe and "soup" pipe, they tell us they have had accidents, — that they don't intend in the future to have accidents, and that when they get fairly at work they will be all right.

But, in reply, we say a slaughter-house should be so situated that even if there are accidents there will be no danger. The weakest link of the chain, not the strongest, determines the amount of strain the whole may be safely put to. The minimum quantity of water furnished by a water-supply in twenty-four hours — not the maximum quantity — shows the capacity of the supply. So the question whether a slaughter-house may be safely placed in any given locality depends upon whether there can be any injury if the business is negligently carried on, and not upon the effect if the business is carefully carried on; and a slaughter-house so situated that it will, if carelessly conducted, be detrimental to important and vital interests, is where it ought not to be. An exigency arises for the application of the general rule I have stated.

It is plain on this evidence that these respondents do not yet know whether their plan will work well, or will, indeed, work at all. Never before was any business subjected to so many changes in so short a time.

In the first place, they intended that the drainage-matter should run through the drain-pipe by the force of gravitation. But they were

obliged to apply their force-pump. The pipe was not laid to stand such pressure, and at first all the joints were repaired; and, as that did not prevent the leakage, the whole pipe was re-laid.

Then they intended to have their muck-bed out here [pointing to the map]. It is not here, but there [pointing to the map]; the soup was to run from the second story of the slaughter-house, upon the muck-bed, by the force of gravitation, in pipes above the surface of the ground. But they actually put the pipes under ground, and by a force-pump drove the soup through. The pipe was not strong enough to stand the pressure: it burst, and now they have taken it from the ground, and suspended it in the air. And so on with their filter-beds, very essentials of the business.

But what have you to say of those muck-beds? Is there any experiment known to you as sanitary men, which goes to show that that muck-bed will answer the purpose at all? and is this the place to try such experiments? Will the bed work in winter when the ground is frozen? Are you sure that it will not be an intolerable nuisance of itself by reason of the animal matter which is to be deposited there? Are you satisfied that in this respect the plan of the respondents will work at all? My belief is, that this "soup" cannot be run there for any length of time without creating a nuisance. The rejected proposition of the Brighton butchers was infinitely better in this respect. They proposed to cart away all such matter, and not leave it upon the ground a short distance from the building.

The joints of the drain-pipe will get out of order. They gave out once, they will give out again. The dryer has met with one accident, it will meet with another; and the putrescent animal matter will be kept in the building again as it then was. The pipes to the muck-beds will again burst. All these things are to have bad working times; and you must consider that taking things as they are, and men as they are, this slaughter-house is not at all times to work with the regularity of a good watch, but is to have many and troublesome accidents.

I have now said in a somewhat desultory way all that I think your time will allow. I have not considered the evidence much in detail, because there is really little if any conflict in it, and because, with your experience in such matters, I have not felt that any comments of mine would aid you. I have simply laid down one rule of action that I think you should adopt in these cases, and some of the leading reasons why you should adopt it.

In substance, we ask you to apply the rule here, and to say that the business of slaughtering shall not be carried on in that building, because it is too near the source of a water-supply; because the consequences of any mishap or negligence are so serious, that it is inconsistent with the public safety or the public health, to take the risk of carrying on that business there. We ask you to do this because it is in accordance with the spirit and policy of our laws; because it is the only just course, and because finally it is the only safe course. We ask this of you because, in the simple but expressive language of the statute creating your official existence, you have "cognizance of the interests of health and life among the citizens of this Commonwealth."

We ask it of you in the name of the great public whose health and lives are thus committed to your charge. We ask it finally in the name of that most solemn and imperative of all laws, whether human or divine, — the law of duty.

By the advice of the Board, Professor W. Ripley Nichols is making experiments for Messrs. Niles Brothers in order to ascertain how efficient is the present process of disposing of the soup, and to devise a better system, if such shall prove to be required, in order to avoid any danger of polluting the water-supply of Cambridge.

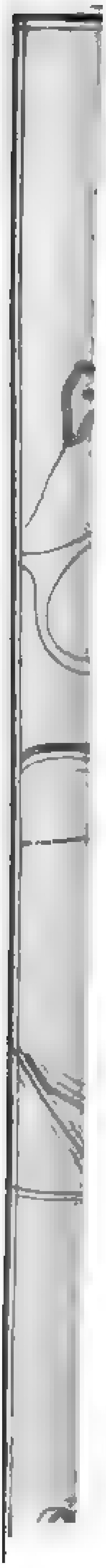
The sewage is "disinfected" with carbolic acid before being discharged into Alewife Brook; and it is hoped that there will be no source of offence at that point before the construction of a sewer, which is necessary on other grounds.

Some of the privies for the workmen have been constructed with movable receptacles, so as not to contaminate the soil; the rest are to be so arranged.

The stinks complained of at the hearing were mostly due to the fact that slaughtering was begun before the firm were ready to dispose of their refuse in a proper manner. They need not be repeated.

The water-supply of the city of Cambridge need not be contaminated from the slaughter-house of Messrs. Niles Brothers, if the directions of the State Board of Health are thoroughly followed out.

By reference to the results of the chemical examinations, given on pp. 119 and 120, it may readily be seen that the water of Fresh Pond contains a very large amount of ammonia and albuminoid ammonia, while the water from the conduit is shown to be largely from a source which has organic matter in it to an excessive degree. These points, however, will be more fully



discussed by the commission appointed by the city of Cambridge to report on their water-supply, and fall more properly under a different head, for future consideration by the Board.

The accompanying map shows all the important points referred to during the hearing, the levels being given in underlined figures. The small plate represents the general situation of the slaughter-house, &c.

Judgment has not yet been given; and, in the meantime, the slaughtering establishment remains under the supervision of the Board.

A CONTRIBUTION

TO

THE STUDY OF VENTILATION,

BY

EDWARD COWLES, M.D.,

RESIDENT PHYSICIAN AND SUPERINTENDENT OF THE BOSTON CITY HOSPITAL;

WITH

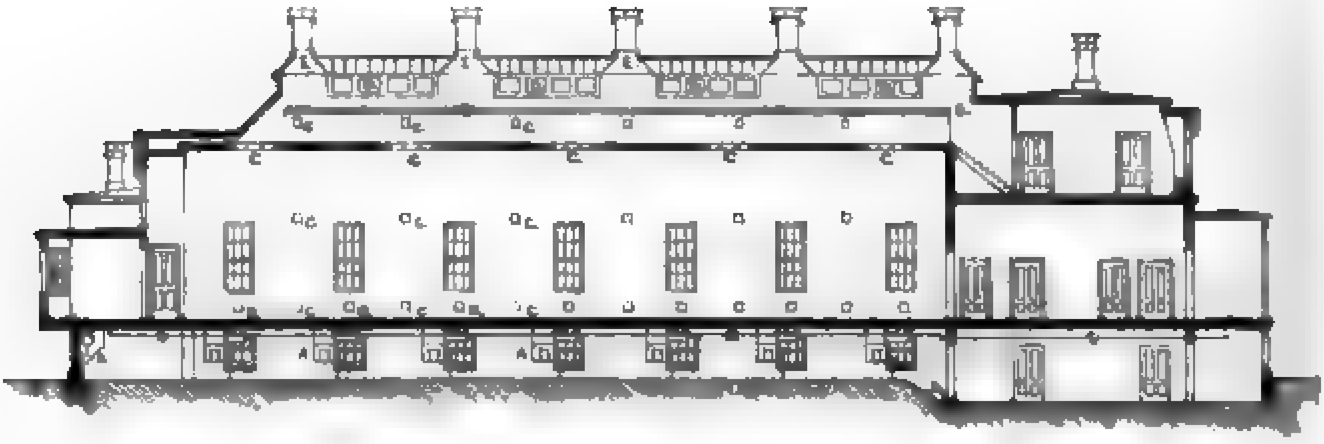
CHEMICAL EXAMINATIONS,

BY

EDWARD S. WOOD, M.D.,

PROFESSOR OF CHEMISTRY, HARVARD MEDICAL SCHOOL.

PLATE Nº 1.

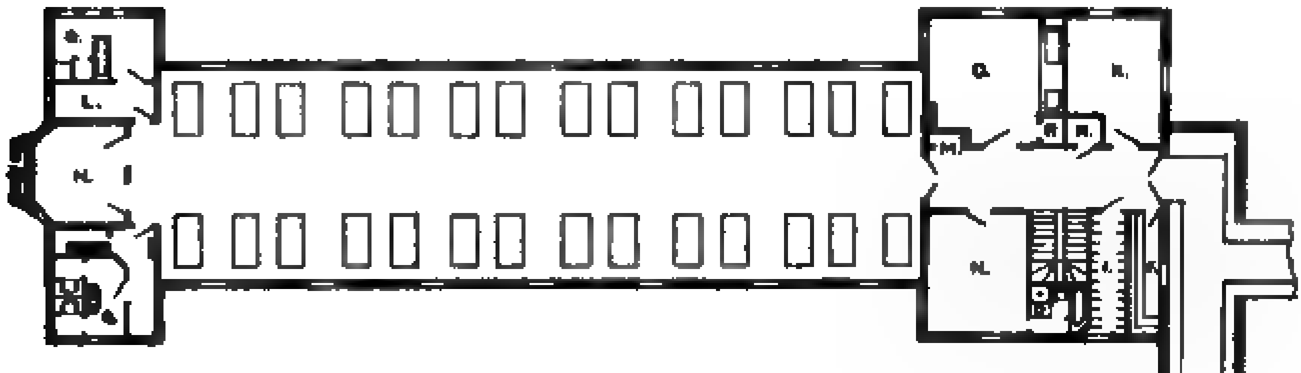


LONGITUDINAL SECTION OF ONE STORY BUILDING

FEET

A. CASINGS OF STEAM-RADIATORS.
B. INLETS FOR WARM AIR.
C. OUTLETS FOR FOUL AIR.
D. SHUTTERS COVERING LOUVRE OPENINGS IN WINTER.
E. VENTILATORS IN GLAZED ROOF OF VENTILATING CHAMBER.
S. STEAM PIPES.

F. LINEN ROOM.
G. BATH ROOM.
H. DAY ROOM.
I. PATIENTS' WARDROBE.
K. SPECIAL WARD.
L. LAVATORY.
M. MEDICINE CLOSET.
N. NURSES' ROOM.
O. DINING ROOM.
P. DUMB WAITER.
Q. WATER CLOSETS.
R. DRYING CLOSET.



BOSTON CITY HOSPITAL

ONE STORY SURGICAL WARD. 28 BEDS.

A. J. B. Del.

THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST. BOSTON

A CONTRIBUTION TO THE STUDY OF VENTILATION.

THE Boston City Hospital was planned to consist of three-story pavilions with connecting corridors, and was partly built upon that plan. After ten years' occupation, there were added, in 1875, several buildings, two of which were one-story wards. Some observations made in one of these wards were published in a Report on Heating and Ventilation, prepared for the Trustees of the Johns Hopkins Hospital, by John S. Billings, Surgeon U.S.A., in 1878. These observations have been repeated, with some further experiments to determine the facts as to the supply and distribution of fresh air in the wards, and the general purity of the atmosphere in them; and this paper has been prepared to illustrate the results obtained.

The building in which these observations were made contains one ward, 94 by 26½ feet in the clear, which has seven opposite windows and fourteen beds on each side.[1] The windows have double sashes. The height of the ward from the floor to the centre of the arched ceiling is twenty feet, or an average of 18.42 feet. Each bed has a floor area of 88.45 square feet, and an air space of 1,629 cubic feet. The total air space of the room is about 45,600 cubic feet.

There is an open free air space, containing only heating-apparatus, under the ward. The cold air is introduced through openings in the outer basement walls, and passes immediately over the steam-radiators, of which there is a separate one for every flue. The air then enters the ward only through openings under each window, fourteen in

[1] See plate No. 1 for a floor-plan and longitudinal section of this

each inlet equal to one square foot of clear opening. Each steam-radiator in the basement is incased with galvanized iron, forming a small chamber in which a switch-valve directs the fresh air, so that it passes either through the coil so as to be warmed, or unwarmed directly into the flue above. A wire attached to the switch-valve leads to the room above, where, by the use of a key, the valve can be adjusted to alter the temperature of the air entering the ward. The volume of entering air can be changed only by opening or closing a sliding valve covering the inlet through the basement-wall, and this is under the sole charge of the engineer.

The foul air escapes through five large openings along the centre of the arched ceiling, each about three by six feet,—total clear opening forty-nine square feet,—into the ridge-chamber, and thence either through the free openings in the sides of the chamber, above the roof, or through five ventilators, each two feet in diameter, on the top of the ridge, giving a total of clear outlet opening of fifteen square feet. The side openings are closed in winter, when also the openings in the floor of the chamber can be partly or wholly closed, and the ventilation aided by the flues, fourteen in number, in the outer walls of the building. These side flues prove in practice not to work unless the openings in the ceiling are quite entirely closed. The ventilating chamber is warmed, when necessary, by steam-pipes.

The results of the latest, or sixth, series of observations are confirmatory of the preceding ones, and are given in the following tables. Table No. 1 shows the amount of air introduced into and discharged from the ward, the amount of heat imparted to it, the general atmospheric conditions existing at the time, as to pressure, humidity, direction and force of winds, &c., and covers a period of one week.

During that period, the range of temperature observed was from 18° F. to 49° F.; of humidity, from thirty-one to one hundred per cent of saturation; and there was considerable variation of atmospheric pressure. The first object of these observations was to ascertain the amount of air introduced into the ward; and in this series it is shown that the hourly supply per bed was continuously something more than nine thousand cubic feet, or at the rate of two and one-half

feet per second, — a large amount. This result is obtained from taking an average of the velocities at all of the registers, at each observation. The uniformity of the air-supply, as well as its volume, is remarkable, considering the variation of the atmospheric conditions. This uniformity was due to the fact that during the progress of the observations some pains were taken to maintain, at the registers, a uniform velocity of entering air, of about three feet per second, as shown by Casella's air-meter. This was easily done by adjusting the slides covering the fresh-air inlets, each of which has one square foot of clear opening, and was generally, during the week of the observations, half closed, or almost entirely closed in very windy weather. On some days no change of this adjustment was needed: on others two or three such changes were necessary.

It should be stated that the velocity of the entering air was measured as it passed through a box one foot deep, open in front and back, with an area of one and a half square feet, which was placed before the register; the air-meter being held at a point near one of the lateral sides and just below the centre of the box, where, as was ascertained from experiment, an average velocity for its whole area was found. The volume of air-supply thus measured was apparently sufficient to change the atmosphere of the ward between five and six times per hour. In the previous observations, the volumes equalled the later ones in some instances, but were variable, because less care was taken in the adjustment of the valves. There is reason to believe, however, that these later readings of the velocities of the entering air are somewhat too large, from the probability that the anemometer was held a little too near the top of the box placed in front of the register, thus indicating a higher velocity than the real average of its whole area. There should probably be a somewhat greater difference, also, than is shown by Table No. 1, between the measured amounts of entering air, and of that escaping through the ceiling-outlets, to account for the amount that may have entered by perflation through the walls of the wooden building, and by cracks, joints, &c.

Taking together all the observations that have been made, including the previous series made at the same season of the year, we find an average of 8,000 cubic feet per head per

TABLE No. 1. — *Record of Observations on Heating and Ventilating at the Boston City Hospital for the week ending Dec.* 10, 1878.

DAY OF THE MONTH OF DECEMBER		Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.
Daily mean of Barometer	–	29.476	29.611	29.806	30.069	30.356	30.164	29.279
External Temperature	7 A.M.	39.	35.	26.	17.5	19.	23.5	42.5
	2 P.M.	43.5	34.	34.	27.5	28.	26.5	49.
	9 P.M.	36.5	29.5	26.5	21.	23.5	33.	53.
Relative Humidity	7 A.M.	91	75	63	76	77	80	100
	2 P.M.	96	61	57	48	38	94	100
	9 P.M.	90	73	63	71	60	84	100
Direction and Velocity of Wind, and State of Weather	7 A.M.	S.E.8,Lt. R.	N.W.15,Cd.	W. 15, F.	N. 9,C.	N.W. 10, C.	W. 5, Cd.	S. 4, R.
	2 P.M.	S.E.5,Lt. R.	N.W.18, F.	W. 17, F.	N.W. 13,C.	N.W. 18, F.	S.E. 9, S.	S.E. 24, R.
	9 P.M.	W. 8, Cd.	N.W.15,Cd.	N.W. 16, C.	N.W. 11,F.	N.W. 6, C.	S.E. 12, R.	S.E. 50, R.
Temperature of air entering Ward at the registers	7 A.M.	93.	92.	95.2	93.1	94.7	94.8	93.5
	2 P.M.	92.3	92.1	90.8	94.2	93.1	96.1	90.
	9 P.M.	92.3	94.3	92.2	93.6	94.1	92.2	92.
Temperature of air at floor of Ward in centre,	7 A.M.	67	67	67	64	66	66	68
	2 P.M.	68	67	67	66	66	65	67
	9 P.M.	67	67	65	66	66	66	64
Temperature of air at head of beds	7 A.M.	69	69	69	68	68	69	70
	2 P.M.	70	68	68	69	68	69	70
	9 P.M.	68	68	68	68	69	69	70
Temperature of air at ceiling	7 A.M.	75	76	73	74	74	74	76
	2 P.M.	80	74	75	75	74	75	75
	9 P.M.	77	74	76	74	73	75	73
Relative Humidity in Ward, and Temperatures by Dry and Wet bulbs		Dry, Wet, R.H.	Dry, Wet, R.H.	Dry, Wet, R.H.	Dry, Wet, R.H.	Dry, Wet, R.H.	Dry, Wet, R.H.	Dry, Wet, R.H.
	7 A.M.	69 54 31	71 54 25	71 51 15	70 55 32	69 51 19	68 52 26	70 54 28
	2 P.M.	72 58 38	69 52 23	69 51 19	69 53 27	70 56 36	69 50 16	70 59 48
	9 P.M.	70 56 36	73 54 21	68 52 26	68 55 38	69 54 31	70 55 32	70 59 48

Temperature of air in Ridge Ventilating Chamber	7 A.M.	81.	76.4	80.6	83.2	79.6	83.	86.6
	2 P.M.	86.8	83.	81.6	80.8	80.2	83.4	81.2
	9 P.M.	87.8	78.8	81.	81.6	82.4	83.	78.
Relative Humidity in Ridge Ventilating Chamber	7 A.M.	27	25	14	10	14	16	22
	2 P.M.	24	21	14	15	17	17	20
	9 P.M.	24	18	15	26	18	25	26
Velocity in feet per minute of air entering Ward through registers	7 A.M.	220.6	208.3	205.5	205.3	217.7	214.8	207.7
	2 P.M.	197.2	206.1	207.5	207.5	218.5	220.5	208.2
	9 P.M.	213.3	219.4	200.4	197.9	206.9	199.7	211.8
	Daily Mean.	215.7	211.2	204.4	203.5	214.3	211.6	209.2
Volume of air entering Ward per hour by registers	-	271,782	266,112	257,544	256,410	270,018	266,616	263,592
Hourly supply per bed	-	9,706	9,503	9,198	9,157	9,643	9,522	9,414
Velocity of air in outlets in ceiling	7 A.M.	104.2	101.8	106.8	106.4	103.6	107.6	107.4
	2 P.M.	112.8	101.8	103.4	107.	100.	112.8	100.
	9 P.M.	107.4	117.4	99.	105.6	106.6	100.4	106.8
	Daily Mean.	108.1	107.	103.	106.3	103.4	106.9	104.7
Volume of air discharged per hour through outlets in ceiling	-	317,814	314,580	302,820	312,522	303,906	314,286	307,818
Velocity of air in Ridge Ventilator	7 A.M.	418.2	416.4	382.8	387.2	381.4	429.8	373.8
	2 P.M.	371.	382.6	369.4	379.8	402.8	437.6	326.8
	9 P.M.	386.4	413.2	372.4	346.4	365.8	373.6	426.6
	Daily Mean.	391.8	404.6	374.8	371.1	383.3	413.6	375.7
Volume of air discharged per hour through Ridge Ventilator	-	352,620	364,140	337,320	333,990	344,970	372,240	338,130

hour, or two and one-fourth feet per second, which would be the nearest approximation that can probably be made to the actual air-supply.

The percentage of humidity in the ward was at times very low. The dry and wet bulb thermometers used were carefully tested by Huddleston of Boston, just before the observations were made; and the readings were taken from the Relative Humidity Table of the United States Signal Service. The thermometers were placed at a point six feet from the floor, at the centre of the ward. The meteorological observations of the external air were furnished by the United States Signal Office in Boston.

I believe that no discomfort has been felt, or ill effects produced, from the low relative humidity, even on the occasions when there was only fifteen to twenty-one per cent of saturation. According to De Chaumont, so great dryness is inconsistent with a healthful condition of the atmosphere. Certainly, in this ward, there is uniformly observed a remarkable absence of complaint of any kind that can be ascribed to the condition of the air; and a peculiar feeling of its freshness and purity is frequently spoken of by those who enter the room.

These conclusions do not accord with the theory that the uncomfortable sensations felt in dry, warm rooms, are due to absence of moisture, as held by Mr. Robert Briggs of Philadelphia;[1] but rather are corroborative of the probability suggested by Dr. Billings,[2] that such sensations are really caused by an insufficient supply of fresh air. We have in this case an abundant air-supply, very low relative humidity, and entire comfort as to its temperature and purity. The incoming air at the registers is very uniformly a little over the temperature of air exhaled from the lungs, or 90° F. The general uniformity, also, of the temperatures at the floor, heads of beds, and ceiling, and of the difference between them, is also notable.

These observations, so far, are little more than corroborative of those published last year in Dr. Billings's report,

[1] On the Relation of Moisture in the Air to Health and Comfort. By Robert Briggs. Journal of the Franklin Institute, January, February, March, and April numbers, 1878.

[2] Report on Heating and Ventilation for the Johns Hopkins Hospital.

excepting the demonstration of the ease of control of the heating and ventilating apparatus of the wards, and of the practicability of maintaining a very uniform air-supply and temperature therein, during the variable weather of the season, as during the week of the observations. Aside from the interesting results thus far shown in Table No. 1, it serves chiefly here as a basis of collateral experiments to ascertain the manner of the distribution of the fresh air throughout the room, the problem being to determine whether or not it was well diffused.

In Plate No. 2 are shown perpendicular cross-section plans of the ward, through the middle pair of opposite windows, and therefore through the inlet openings under them. A cord was stretched across the room, at the height of twelve feet from the floor; at distances from each wall of three, six, and nine feet, and at the centre, were hung small lines upon which were tied a number of tags, at heights of three, six, and nine feet from the floor. The sectional area of the ward was thus plainly marked off by fixed points of observation. With Casella's air-meter held at these points, the velocities of the air-currents from the registers were taken. The air-meter used requires, at a velocity of twenty feet per minute, a correction of +26. Therefore low velocities could not be measured by the instrument; and, at the points marked 0, there was really a positive movement of the air. The results of this experiment are shown in Plate No. 2, Fig. 1, and are like those of many other such experiments, as to the general upward-curving direction of the main current, its retardation, and the widening of its track. The figures at the registers show the temperature and average velocities at each, of the entering air. Those at three feet distant and two feet from the floor, in this diagram, are greater than is noted at the register, for they are the continuation of the maximum velocities from its upper part. An inspection of this diagram seems to lead at once to the conclusion that "the distribution and diffusion are not what they should be, and that probably a very considerable portion of the fresh air introduced escaped at the ceiling, without thoroughly mixing with and diluting the foul air of the room."[1] It would also seem that

[1] Dr. Billings's Report, p. 70.

there were stagnant areas of air at the points marked II., IV., and V. This question will be discussed farther on. The general atmospheric conditions are shown in the marginal notes. The diagram is typical of those obtained in clear fine weather.

The next step was to determine precisely, by experiment, what were the movements of the gentler currents of air in the line of the same section shown in the diagram Fig. 1. This was easily done by developing the vapor of muriate of ammonia at the points of observation, and brought out the striking results shown in Figs. 2 and 3. These diagrams illustrate recent experiments; and, as to air-meter readings, &c., are typical of those obtained at other times, under meteorological conditions similar to those here indicated. Fig. 2 shows results accompanying an atmosphere saturated with moisture, a low barometer, and moderate temperature. The entering volume of air sooner lost its velocity, and rose with less rapidity, than when dryer. The external temperature here given, 60° F., was taken near the ward; and, its situation being somewhat more sheltered, the thermometer gave a higher reading than at the Signal Office. Fig. 3 shows a quicker movement of the air accompanying a lower external temperature, and a significant difference is to be seen between the currents of the opposite sides of the room. On the left a lower velocity, and a higher temperature of entering air, produced a quicker upward curve and greater velocity at the upper levels than is shown on the right side of the room. In general it has been observed that when the velocity and the temperature of the entering air are diminished at the same time, the inflowing currents describe a lower curve, and meet at a lower point in the centre of the room. Therefore, to gain the best diffusion of the fresh air, its temperature should not be above 90° F., and its velocity a hundred and eighty feet per minute or somewhat less.

The velocity of the air escaping through the outlet in the ceiling is very high, as shown in Fig. 3, the usual rate observed being about one hundred feet per minute. It seems to me that these observations indicate that a large area of ventilating outlets is the best, because, the movement of air through them being gentle, the fresh air entering the room

below is less liable to be drawn into narrow rapid currents not mixing with the surrounding atmosphere. During the experiment shown by Fig. 3, the ceiling-outlet was one-half closed, while it was entirely open on the previous occasions of Dec. 6 and 10.

The movements of the little clouds of vapor tended gently along the floor toward the centre of the room, and to diverge laterally from this line. These movements are characteristic of all the observations I have made. At higher levels of three, six, and nine feet, &c., from the floor, the movements were upward, tending toward the centre with few exceptions, and veering gently laterally, toward, or away from, the point of view of the observer. In very cold weather there was sufficient chilling of the air on the inner side of the window-panes (even though with double sashes), together with some probable leakage of air through the cracks about the windows, to produce a downward movement of air within a limited area. This is shown in a marked degree in Fig. 3, and is less apparent in Fig. 2, when the weather was warmer. This lateral motion cannot well be shown in these diagrams. This experiment with the vapor, often repeated, has seemed to me to demonstrate an active and constant motion of the whole body of the air of the room, with constant replacement by fresh air, permitting no stagnant areas.

To fortify this conclusion, the experiment was extended by repeating it at sixteen other similar imaginary sections of the room, viz., through every pair of opposite windows, and at points midway between the consecutive pairs of windows. A light stick reaching to the height of fifteen feet was placed upon a small platform of heavy boards with a roller under each corner, and was stayed with cords. From points three, six, and nine feet high, &c., slender arms ran out two feet, and upon the end of each were placed the small cups containing hydrochloric acid and ammonia, and thus the vapor could be developed simultaneously at the six points in a perpendicular line from the floor to the height of fifteen feet.

With this apparatus the results illustrated in Plate No. 3 were obtained. These diagrams show the movements of the air in the different strata from the floor upward, at the levels indicated. The observations were taken on the same day as those of Fig. 2, Plate No. 2 (see also Table No. 1, for other

data of Dec. 10), beginning in the morning, and continuing during the afternoon till nightfall. At the beginning, there was little wind: four miles per hour at seven A.M., increasing to twenty-four miles at two P.M., and to fifty miles at nine P.M. The observations were begun at the perpendicular section nearest the entrance door, and thence along the ward. I have perceived, on other occasions as well as on this, little if any difference in the directions of the gentler air-currents caused by changes of the wind, provided there was proper adjustment of the inlet-valves to control the volume of entering air on the windward side. The other conditions, of external air saturated with moisture, and a low barometer, will be remembered. As may be seen by reading the signs according to the directions given, there was in all parts of the room a constant movement of the whole body of the air upward to the outlets above in the ceiling; the positions of which are shown on the plans by dotted rectangles along the centre of the ward. There was no downward motion anywhere.

The slight tendency shown at the lower two levels, of motion toward the entrance of the room, has been observed before, even against the direction of the wind outside. These movements were gentle, and not marked in proportion to the rate of those of the more positive upward currents, which can be shown only by small circles in the diagrams. This lateral tendency toward the entrance seems to be due to the fact that this end of the room is more covered and protected by adjoining ones than the outer end, which is more exposed to pressure of cold air through the walls. More than this, there are two windows with single sashes high up in the outer end wall; and from these a thin current of chilled air is found to fall in cold weather, and apparently to move along the floor, producing in part the result shown in the diagrams. There is no reverse motion in the upper strata. So far as these data go, it therefore appears that there is excellent diffusion of the fresh air, and dilution of the foul air.

In further pursuance of the investigation of this subject, the air analyses made last year by Professor Edward S. Wood, M.D., were continued, but more extensively than before. The results are given in Table No. 2, with accompanying meteorological observations of the same dates.

TABLE NO. 2. — *Examination of Air for Carbonic Acid, showing amount per* 1,000 *volumes. By Professor* EDWARD S. WOOD, M.D.

Meteorological Observations showing accompanying atmospheric conditions. Experiments in a one-story ward for 28 patients. Floor space per head, 88.45 feet. Cubic space: total, 1,629 feet; effective, 1,061 feet.

Number.	LOCATION.	Dec. 31, 1877. 2 P.M.	Jan. 5, 1878. 2 P.M.	Jan. 12, 1878. 2 P.M.	Dec. 7, 1878. 2 P.M.	Dec. 10, 1878. 2 P.M.	Dec. 19, 1878. 2 P.M.	Dec. 24, 1878. 2 P.M.	Dec. 27, 1878. 2 P.M.	Jan. 3, 1879. 2 P.M.	Jan. 15, 1879. 2 P.M.	Jan. 19, 1879. 10 A.M.	Average.	No. of Samples.
1	External air	0.402	0.332	0.421	0.301	–	0.326	0.277	0.358	0.369	0.262	0.208	0.325	10
2	Centre of ward, 2 feet from floor .	0.644	0.500	0.460	–	0.557	0.433	0.315	0.396	0.375	0.419	0.371	0.447	10
3	Side, between beds, 2 ft. from floor,	–	–	0.479	0.466	0.434	0.469	0.584	0.447	0.449	0.486	0.337	0.461	9
4	Centre of ward, 12 feet from floor .	–	–	0.677	0.415	0.542	0.739	0.532	0.505	0.415	0.476	0.438	0.526	9
5	Side, 12 feet from floor	–	–	0.660	0.555	–	0.892	0.513	0.698	0.502	0.457	0.361	0.579	8
6	Above opening into ventilating chamber	0.730	0.722	0.827	0.366	0.593	0.736	0.377	0.489	0.402	0.490	0.548	0.571	11
	External air: —													
	Barometer	29.36	29.81	29.89	30.005	29.39	30.201	29.74	29.562	29.118	30.394	29.904	–	–
	Thermometer, dry bulb . . .	36°	32°	44°	27°5′	49°	28°5′	24°	27°5′	13°	10°	19°	–	–
	Thermometer, wet bulb . . .	29°	26	36°	23°	49°	23°	19°5′	25°5′	10°5′	7°	17°	–	–
	Dew point	14°	12°	21°	12°	49°	9°	5°	21°	1°	-5°	12°	–	–
	Vapor in cubic feet of air in grains,	100	.92	1.35	.92	3.95	.81	.68	1.35	.57	–	.92	–	–
	Relative humidity	39	40	37	48	100	39	42	76	53	38	69	–	–
	Wind, direction and force . .	N.W.18	W. 24	N.W.45	N.W.13	S.E.24	N.W.20	W. 25	N. 12	W. 29	W. 16	W. 9	–	–
	Weather	Clear.	Clear.	Clear.	Clear.	Rain.	Clear.	Clear.	L.snow.	Fair.	Cloudy.	Clear.	–	–
	Inner air: —													
	Thermometer, dry bulb, 6 feet from floor	70°	70°	75°	69°	70°	–	–	66°	–	–	–	–	–
	Thermometer, wet bulb, 6 feet from floor	–	52°	57°	53°	59°	–	–	50°	–	–	–	–	–
	Dew point	–	28°	38°	33°	49°	–	–	28°	–	–	–	–	–
	Vapor in cubic feet of air . . .	–	1.82	2.66	2.21	3.95	–	–	1.82	–	–	–	–	–
	Relative humidity	–	21	26	27	48	–	–	23	–	–	–	–	–

The numbers in the left-hand column of Table No. 2 refer to locations marked I., II., IV., V., and VI., in Plate No. 1., Fig. 1. Location III. is at points between beds most distant from and out of the line of the main currents of entering air, and is not shown in the diagram. The ward contains twenty-eight beds, of which there are rarely any vacant. The ground was frozen on the dates previous to Jan. 3, 1879, and on the subsequent dates was covered with snow. The average, .325, of carbonic acid per one thousand volumes of external air, as shown by this table, is rather low. This is from ten samples. The Report of the State Board of Health of Massachusetts for 1871 gives the result of twenty-one observations of the outer air of Boston in *spring* as .385; and of eleven observations in Cambridge in *winter*, as .337 per one thousand volumes.

Dec. 31, 1877, Jan. 5 and 12, 1878, being "visiting days," there were present, from two to three P.M., a number of persons beside the regular occupants of the ward. There are usually twenty or more visitors on such occasions. On these dates the samples of air from the lower level (Nos. II. and III.) of the ward were taken at points three feet above the floor, while at other dates such samples were taken at two and a half feet high.

DEC. 7 AND 10, 1878.—Doors of the ward closed, and ventilators in the ceiling all open. Some visitors present during part of the examinations. No record made. On the 10th, the external air was saturated with moisture: see Plate No. II., Fig. 2, and Table No. 1, where also other data of the 7th are given.

DEC. 19.—Doors closed. Twenty visitors entered just previous to analyses Nos. 4 and 5, and after the completion of Nos. 2, 3, and 6.

DEC. 24.—Some visitors present during part of the analyses,—no record made. Doors at entrance of ward open during analyses Nos. 2 and 6. Fresh warm air enters the hall, and an adjoining open room, by a total register area of three square feet. After analyses 2 and 6 the doors were closed. The area of the five outlet-openings in the ceiling was reduced one-half; the two outlets nearest the entrance being closed, and the central one half closed. All the samples of the air of the ventilating chamber (location VI.)

were taken from a point one and a half feet above the central outlet in the ceiling. The outlets were not properly adjusted, for uniform ventilation along the ward, on this date.

DEC. 27.— No visitors present. Doors closed, and ventilators all open, during analyses.

JAN. 3, 1879.— Thirty occupants. High wind, and only one-half of the three central outlets in ceiling open.

JAN. 15.— Twenty-six occupants during analysis No. 6, and twenty-nine during the remainder. Doors all closed, and one-half of all outlets in the ceiling closed.

JAN. 19.— Twenty-eight occupants. Doors closed, and first four outlets open,— last one closed.

In the earlier analyses complete series were not made, and some others were spoiled by accidents.

The column of averages in the table gives the average results of the determinations of carbonic acid at each of the locations designated in Plate No. 2, Fig. 1. Assuming that there was a sufficient number to represent a correct average of the various conditions, &c., the results are very significant. The lowest percentage, .0447, of carbonic acid in the room, was at the centre, two feet above the floor, definitely settling the question as to there being a stagnant area of air at that point.

The next highest amount of carbonic acid, .0461 per cent, was found at the points between the beds, and the most remote from the fresh-air currents: see diagrams, Plate No. 3. These samples from locations II. and III., nineteen in all, give an average of .0454 per cent of CO_2. In calculating this average, only one side of the ward is represented in proportion to the number of samples from the centre. If, therefore, we double the amounts from location III. to represent both sides of the room, and to the sum add the amount from the centre, a more correct average, .0456 per cent of CO_2, will be obtained. The samples being taken from different points in the ward, they must represent the general condition of the atmosphere breathed by the sick in their beds.

The point No. IV., twelve feet from the floor at the centre of the room, was chosen because it was directly in the track of the main upward current of fresh air from the registers.

If any considerable proportion of the fresh air proceeded directly to the ceiling without mixing with the foul air, we should find evidence of it at that point. On the contrary, we find increased impurity, and a percentage of .0526 of carbonic acid,—a greater amount than at the lower levels of the room.

As was to be expected, there was a somewhat larger amount, .0579 per cent, at location No. V., twelve feet above the floor and three feet from the wall. This fact significantly coincides with another one which may be obvious upon inspection of the diagrams of Plates Nos. 2 and 3; viz., that the patients lying in bed with their heads at about two and one-half feet distant from the wall, and their visitors sitting by the heads of the beds, as they did during a large part of the observations, the carbonic acid exhaled by them, at a temperature of 90° F., rising upward from its source, as depicted in the diagrams, was found in corresponding proportion in the samples of air taken above. There is corroboration of this inference in the observations of Dec. 19, 1878, and in the fact that the average amount of carbonic acid, .0571 per cent, found in the ventilating chamber, is between the average determinations at points Nos. IV. and V.

Calculating the amount of carbonic acid found at the height of twelve feet by doubling the amounts from the side of the room, and adding those from the centre, as was done at the floor level, there is obtained an average of .0560 per cent of carbonic acid. In the same way we find a general average of .0505 per cent of carbonic acid from all the determinations made within the room, including both the upper and the lower levels.

The results of these analyses seem thus to sustain the conclusions derived from the mechanical experiments illustrated in this paper, that there is an active constant upward motion of the whole body of the air of the room, with constant replacement by fresh air, permitting no stagnant areas, and that there is excellent diffusion of the fresh air, and dilution of the foul air.

Further proof of the correctness of those conclusions is not wanting. The mean amount of carbonic acid found at the lower or *occupied* level of the room was .456 per one thousand volumes. Taking from this the mean of the outer

air, .325, we have .131 per one thousand (or .000131 per cubic foot), due to respiratory impurity. Assuming that each occupant gives off at least 0.6 of a cubic foot of carbonic acid per hour, we find the amount of air supplied and *utilized* per head to be as follows: $\frac{.6}{0.000131}$, = 4,580 cubic feet per hour, as the theoretical air-supply per head.

The occupancy of the ward at the time of the observations, it being the accident ward, and most of the patients being in bed, consisted of twenty-eight patients plus visitors, nurses, and the observers, to the number of at least ten persons as an average, giving a total of thirty-eight persons present during the observations. This would give twelve hundred cubic feet of air space to each individual in the ward for the time being; and it follows that *the air was changed effectively* 3.81$\frac{3}{8}$ *times per hour per head, or ninety-one and one-half times in twenty-four hours.* This is an extraordinary result, and far above the standard of "good" ventilation.

Now, comparing this theoretical amount with the average resulting from the measurements of the entering air by the air-meter, — viz., a volume of 16,000 cubic feet at each of the fourteen registers, or a total of 224,000 cubic feet of air per hour for thirty-eight persons, giving an average of 5,894 cubic feet per head, — we have this latter amount by measurement, against 4,580 cubic feet per head calculated from the respiratory impurity. This shows that seventy-eight per cent of the entering air is actually utilized, and that its diffusion and the dilution of the foul air is excellent.

Taking the general average of all the analyses made within the ward, including thirty-six samples of air from both upper and lower levels, and calculating in the same way as above, the following results are obtained, viz.: mean carbonic acid, .0505 per cent; respiratory impurity, .0180 per cent; air-supply per head per hour, 3,333 cubic feet; air of room effectively changed 2.77½ times per hour, or 66½ times in twenty-four hours. This represents the average condition of the atmosphere throughout the room, and is excellent ventilation.

Taking the mean carbonic acid of the eleven samples from the ventilating chamber as an index of the excellence of the ventilation, we shall still have the air effectively changed

forty-eight times per head in twenty-four hours, which is up to the standard of good ventilation; but as these samples were all taken from one point, at the central opening, it might be questioned whether they represent the average condition of the air in the chamber.

A practical conclusion may be drawn from the evidence given by these experiments, as to the proper height of wards. Some unpleasant echoing of the sound of voices and footsteps, experienced in the ward in which these experiments were made, seems to be due to its extreme height and arched ceiling. It would appear from the carbonic acid determinations that there was an accumulation of impurity in the upper part of the room, notwithstanding the large measured amounts of air that escaped through the openings in the ceiling. Still the most satisfactory practical results were gained. The air supplied to the occupants at the lower level of the room was not only very pure, but quite uniform in quality at different points; and there was also satisfactory diffusion of the fresh air, with 78 per cent of it effectively utilized. Even including the whole air-space of the room, we find a respiratory impurity of only .180 per one thousand volumes as calculated above; and Dr. de Chaumont considers any condition which keeps the respiratory impurity within .200 per one thousand as good ventilation.

The respiratory impurity at the lower level, or two and one-half feet above the floor, was .131 per one thousand volumes; of the stratum of air at the height of twelve feet, .235; and of the air in the ventilating chamber, .246 per one thousand. The difference between the last two amounts is so small that they may be regarded as practically alike.

The diagrams of Plates Nos. 2 and 3 show that the force of the extracting power exercised by the ventilating chamber is not immediately felt by the air-currents below, until within a few feet of the outlets in the ceiling. Above the height of twelve to fourteen feet, the inflowing currents of air seem to have quite lost their initial velocity, and the movement is, as a rule, thence directly upward till deflected toward the central openings by the ceiling. The resultant curves described by the points of maximum velocity in each of the inflowing currents of air would not be materially altered by lowering the ceiling to the height last mentioned,

excepting that it might prevent the occasional occurrence of the too quickly turning upward of these currents, which would be an advantage. There certainly appears to be no advantage gained by having the upper six feet of air-space, which would not be more than offset by that gained from the more frequent change of the whole atmosphere of the room that the same volume of air supply would give with the lessened air-space.

It would seem, therefore, that in this case the ceiling might as well be lowered to a height of at most fourteen feet, thus permitting the foul air to escape sooner from the room, instead of occupying the waste space now existing above that level, at the risk of falling again and re-mixing with the air below.

As a practical and most satisfactory conclusion to this inquiry, showing the good purpose to which all these studies tend, I am able, by the kindness of George W. Gay, M.D., one of the visiting surgeons of the hospital, to present the following statement, prepared by him, of the results of treatment in the ward: —

"In June, 1876, two new surgical pavilions were opened at the Boston City Hospital, and important changes in the sanitary arrangements of the old buildings were begun. Previous to this time, there had been several endemics of pyæmia and other septicæmic affections, which had very seriously increased the fatality, as well as retarded the recovery of the patients. In no class of cases was this pernicious influence more conspicuous than in compound fractures of the extremities. During the five years ending June 1, 1874, the mortality in these injuries (157 cases) was forty-one per cent, while, in the two and one-half years following the introduction of improved sanitary conditions, the death-rate (in fifty-one cases) was not quite twenty per cent, — a reduction in the mortality of more than one-half.

"The contrast in the results of the cases treated conservatively — i.e., without amputation — is even more striking. In the later period under consideration, the percentage of recoveries in this class has increased from fifty-six to eighty-seven or more than fifty per cent. In other words, the mortality has decreased from forty-four per cent to thirteen per cent, or from 1 in 2.27, to 1 in 7.69; a very favorable record for a large hospital.

"Amputations have been less frequent, and the results have been more favorable, than formerly. The frequency of and fatality from pyæmia has decreased one-half, and all the affections depending upon blood poisoning have been greatly diminished in the past two or three years.

"In addition to the evidence furnished by the surgical records, it is the unanimous opinion of each and every member of the surgical staff,

that the sanitary condition of the hospital has been very markedly improved since the winter of 1875–6; that erysipelas, septicæmia, &c., have been reduced to a minimum; that severe wounds and large operations give less trouble and anxiety; and that the patients generally make surer, quicker, and better recoveries than in former years.

"These very gratifying results cannot be accounted for on the ground of less extensive injuries, or of a different kind of treatment. The severity of the injuries averaged nearly the same in the two series of cases. The treatment differed in only two exceptions: namely, in the use of the Lister method, and of the compound tincture of benzoin. The former was employed more or less thoroughly in nine cases, and a third of them proved fatal. The latter method was used in a few more cases, with two deaths. Hence it is fair to conclude, as these were average cases, that any gain in the general results was not due to new or improved methods of treatment.

"After making all due allowance for climatic and other influences over which we have no control, there still remains a large percentage of gain in the favorable results, which, it seems to us, can only be explained on the ground of improved sanitary measures, pure air and perfect drainage being of the utmost importance in the treatment of this class of injuries."

The cases since June, 1874, were treated in the ward under examination, with a few exceptions of those under less favorable conditions, chiefly of cases in the female ward, in the older three-story building. The sanitary conditions referred to, as existing prior to the period in question, as well as the improvements made in regard to reconstructing basements, water-closets, drainage, &c., and increasing the air supply, are described in the Medical and Surgical Reports of the Boston City Hospital, second series, Boston, 1877.

Such results as Dr. Gay reports clearly demonstrate the relation of cause and effect in these matters, and fully justify all the labor and the cost of producing them.

HEALTH OF TOWNS.

1. BOARDS OF HEALTH.
2. WATER-SUPPLIES.
3. PREVALENT DISEASES, ETC.
4. CIRCULAR ON DRAINAGE.

HEALTH OF TOWNS.

Boards of Health.

As already shown in the General Report of the Board (pp. xxxv. and xxxvi.), the selectmen of our towns, acting as boards of health, are strongly in favor of a better sanitary organization than that which the present laws afford. A great step has been taken in that direction by the legislature in extending the provisions[1] of the Board of Health Act of 1877 (approved March 13, 1879).

Nineteen State boards of health now exist in our country, and also a National Board of Health, all of them doing valuable work, in the words of the latest State board established, "in that higher line of political economy which is sure to lead a State to increased power and wealth. . . . State after State has caught the salutary influence of the example of Massachusetts; leading men, especially in the medical profession, are giving it their active support; the people are beginning to recognize the safer, better, and cheaper policy of prevention than of the cure of disease, and to understand

[1] Sect. 1. It shall be the duty of the mayor and aldermen in each of the cities of the Commonwealth, which have not already voted to accept chapter one hundred and thirty-three of the acts of eighteen hundred and seventy-seven, to notify and warn the legal voters of said cities to vote upon the acceptance of said act at the then next meeting in said cities respectively for the election of city officers; *provided* the mayor and aldermen have been requested in writing so to do, thirty days prior to the time of holding said meeting, by fifty voters residing therein.

Sect. 2. In case of a severe epidemic, or of danger to the public health, the mayor and aldermen of any city in the Commonwealth where there is no board of health may appoint such a board in accordance with the provisions of chapter one hundred and thirty-three of the acts of eighteen hundred and seventy-seven; *provided* they have been requested to do so by one hundred voters in said city.

Sect. 3. This act shall take effect upon its passage.

that the causes of many of the most dangerous diseases are palpable, easily recognized, and easily avoided."

The replies to our circulars from the boards of health, or selectmen acting as such, in sixteen of the nineteen cities and in 301 of the 325 towns of the State, show a greater interest in measures to promote the public health than ever before, including an increased willingness on the part of the public to co-operate with the sanitary authorities. Excellent work has been done in many places, especially where independent boards of health have been elected, by sanitary inspection, by abating nuisances, by isolating cases of contagious diseases, as far as is practicable, through regulation of school attendance, &c., and by diffusing information among the people. Too often, however, the want of a special board of health, or a failure to support such a board, has resulted in unskilled and inefficient administration of the statutes, if, indeed, they are not neglected altogether.

The law with regard to the establishment of boards of health in the cities of the State was adopted in Cambridge, Lowell, Worcester, New Bedford, Newburyport, Lawrence, Somerville, and Fall River: it was rejected in Fitchburg, Gloucester, Newton, Lynn, and Chelsea; no vote was taken on it in Haverhill, Holyoke, Salem, Springfield, and Taunton.

Of 301 towns, Bridgewater, Brockton, Edgartown, Holliston, Hopkinton, Marblehead, Medford, Milford, Natick, Nantucket, Palmer, Pittsfield, Plymouth, Revere, Stoughton, Wakefield, and Winchester have elected boards of health; in North Andover, the physicians in town generally compose the board; in North Adams and Hingham, boards were elected, but not according to the last law, and so did not serve; in six towns, a physician is added to the board of selectmen. The selectmen serve as boards of health in the vast majority of the towns.

WATER-SUPPLIES.

The boards of health, or the officers acting as such, in answer to the questions with regard to their water-supplies, report as is shown in the following table. Information from the few cities and towns failing to reply to the circulars, although sent to them three times, has been received from the medical correspondents of the Board, except in a few very

small towns, where water from wells or springs would naturally be used. Some wells are used in all the towns having public water-supplies and also in parts of the large cities.

Pollution of public water-supplies is reported only in the case of Cambridge, Lawrence, and the cities and one town supplied by Mystic Pond. The matter most complained of in Cambridge is now under judgment by the State Board of Health; and a full account of it may be found in the report of the hearing in the case of Cambridge *v.* Niles Brothers, pp. 113 *et seq.* Lawrence was supplied with water from the Merrimac River, on the full understanding that the sewage of Lowell was cast into it, ten miles higher up. Mystic Pond has been protected to a considerable extent by the intercepting sewer built by the City of Boston. In Natick a slight pollution of a tributary of their supply is complained of, but the difficulty can easily be controlled by the local board. The supply of Boston has already been considered in the reports of the Board, and will be further investigated.

Cisterns for storing rain-water are complained of, especially when there is no process of filtering; but they may be rendered free from organic impurity by cleaning them often enough, and by having the water filtered.

In Southbridge springs from the hills are reported as liable to contamination from the drainage of houses above them.

Wells are often polluted. They may usually be kept clean, where cesspools, barns, privies, slop-water spouts, &c., are not allowed to contaminate them. It may be noticed that they are reported in most cases in the table as not being polluted; but that statement apparently often means *not contaminated in such a way as to require the interference of the law*, or *not sensibly polluted.*

Poisoning from lead pipes is reported from one town.

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1878.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Beverly	7,271	147	Wenham Lake.		
Billerica	1,881	43	Wells.		
Blackstone	4,640	42	Wells.	No.	
Blandford	964	19	Wells and springs.		
Bolton	987	11	Wells and running water.		
Boston	341,919	7,677	[1]		
Boxborough	318	4	Wells.		
Boxford	834	22	Wells.		
Boylston	895	12	Wells and springs.		
Bradford	2,347	40	Wells.		
Braintree	4,156	67	Wells.		
Brewster	1,219	20	Wells and cisterns.		Danger from leakage from sink-drains.
Bridgewater	3,969	87	Wells, springs, and cisterns.	Yes.	Many wells are polluted by defective drains, slop-water on the surface, &c.
Brimfield	1,201	17	Wells.		

Brockton . .	10,578	154	Wells mostly. Reservoir for use in case of fire.	Yes.	Village thickly settled; no system of drainage; ordinary precautions as to sinks, cesspools, and privies, are frequently entirely disregarded.
Brookfield .	2,660	38	Wells almost entirely.	No.	Except in rare instances, where the well is too near the barn-cellar or privy.
Brookline .	6,675	89	Collecting-basin, near Charles River, through a wooden conduit.		Questions connected with these subjects being now in the courts, we omit answering at present.
Buckland .	1,921	20	From the mountains.	No.	
Burlington .	650	10	No public water-supply.		
Cambridge .	47,838	964	Fresh Pond, Little Pond, and Wellington Brook.	Yes.	By a hog-slaughtering establishment recently erected within a short distance of the pond, close to the line of the conduit connecting Fresh Pond and Little Pond, without proper drainage facilities; and by the drainage of a settlement near the western border of Fresh Pond: both these sources of pollution being in the town of Belmont.[2]
Canton . .	4,192	77	Wells and springs.		
Carlisle . .	548	10	Wells.		
Carver . .	1,127	18			

[1] From Lake Cochituate, Jamaica Pond, Sudbury River, and Mystic Pond. The contamination is apparently not at present dangerous to the public health, but it has been reasonably complained of in some of its portions.

[2] The surface drainage into the pond is not mentioned above. The slaughter-house referred to, as endangering the water-supply of Fresh Pond, is now under the supervision of the State Board of Health. Little Pond and Wellington Brook are not now used. For particulars in this matter, compare the report of the hearing in the case of Cambridge *v.* Niles Brothers, pp. 113 *et seq.*

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

City or Town.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Charlemont . .	1,029	18	Wells and private springs.	No.	
Charlton . .	1,852	20	Wells principally.	No.	
Chatham . .	2,274	52	Wells and cisterns.		
Chelmsford .	2,372	40	Wells.	No.	
Chelsea . .	20,737	352	Mystic Pond.		Committee of city council report "not."[1]
Cheshire . .	1,693	24	Pure mountain-brook water.	No.	
Chester . .	1,396	22	Mountain springs.	No.	
Chesterfield .	746	18			
Chicopee . .	10,335	207	Partially by wells, largely by aqueducts from springs.	Yes.	In regard to wells in some localities where in low grounds or surrounded by many houses. The aqueduct supplies are considered pure.
Chilmark .	508		Wells and cisterns.	No.	
Clarksburg .	670	13			
Clinton . .	6,781	100	Wells.		The water is good as far as we know.
Cohasset . .	2,197	40	Wells.		

Colrain . .	1,099	15	Springs on the hillsides.	No.	
Concord . .	2,676	39	Sandy Pond in Lincoln, and wells.	Not seriously.	As far as we are informed. Have heard of nothing excepting that men and boys sometimes bathe in it.
Conway . .	1,452	25	Wells and running water.	No.	
Cummington .	916	14	Wells and springs.	No.	
Dalton . .	1,759	33	Springs and wells.		
Dana . .	760	7	Wells, and springs running to buildings in lead pipes.	Think not.	
Danvers . .	6,024	117	Middleton Pond, and wells.	No.	
Dartmouth .	3,434	66	Wells, springs, and streams.		Do not know of any particular source of danger.
Dedham . .	5,756	100	Wells and springs.		Are not aware of much pollution.
Deerfield . .	3,414	38	Mostly springs in near hillsides. A few families have wells.	No.	Except as to wells, as to some of which there is much danger from pollution.
Dennis . .	3,369	63	Wells.		
Dighton . .	1,755	29	Springs and wells.	None to my knowledge.	
Douglas . .	2,202	37	Wells.	No.	
Dover . .	650	20	Wells and springs.	No.	
Dracut . .	1,116	8	Wells and springs.	No.	

[1] Compare replies from Everett and Somerville.

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Dudley . .	2,653	54	Wells (good).		
Dunstable .	452	8	Wells.	No.	
Duxbury . .	2,345	36	Wells and a few cisterns.		
E. Bridgewater,	2,808	34	Wells.		
Eastham . .	639	12	Mostly cisterns, and some wells.	We think not.	
Easthampton .	3,972	64	Wells. Reservoirs for fires.		
Easton . .	3,898	51	Wells.	No.	
Edgartown .	1,707	54	Wells.		Generally pure: there are cases where the wells are altogether too near privies, sinks, and drains.
Egremont .	890	17	Wells, cisterns, and springs.	Yes.	Wells sometimes.
Enfield . .	1,065	13	Wells.	No.	
Erving . .	794	9	Wells and springs.	No.	
Essex . .	1,713	28	Wells and cisterns.		Of course generally unpolluted.
Everett . .	3,051	54	Mystic Pond.		Some little fault is found, but not in an official manner.

Colrain . .	1,609	15	Springs on the hillsides.	No.	
Concord . .	2,676	39	Sandy Pond in Lincoln, and wells.	Not seriously.	As far as we are informed. Have heard of nothing excepting that men and boys sometimes bathe in it.
Conway . .	1,452	25	Wells and running water.	No.	
Cummington .	916	14	Wells and springs.	No.	
Dalton . .	1,759	33	Springs and wells.		
Dana . .	760	7	Wells, and springs running to buildings in lead pipes.	Think not.	
Danvers . .	6,024	117	Middleton Pond, and wells.	No.	
Dartmouth .	3,434	66	Wells, springs, and streams.		Do not know of any particular source of danger.
Dedham . .	5,756	100	Wells and springs.		Are not aware of much pollution.
Deerfield . .	3,414	38	Mostly springs in near hillsides. A few families have wells.	No.	Except as to wells, as to some of which there is much danger from pollution.
Dennis . .	3,369	63	Wells.		
Dighton . .	1,755	29	Springs and wells.	None to my knowledge.	
Douglas . .	2,202	37	Wells.	No.	
Dover . .	650	20	Wells and springs.	No.	
Dracut . .	1,116	8	Wells and springs.	No.	

[1] Compare replies from Everett and Somerville.

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Goshen . .	349	10	Mostly wells, some springs.	Only as the result of carelessness occasionally.	One well contaminated by the filtering through from a cesspool imperfectly cemented, used to collect privy deposits, slops, and kitchen-waste for fertilization. Three cases of typhoid-fever consequent.
Gosnold . .	115	3	Wells and cisterns.	No.	
Grafton . .	4,442	70	Wells, springs, and aqueduct.	No.	
Granby . .	812	10	Wells.	No.	
Granville .	1,240	15	Wells usually.	Some are.	By not having sink and barn drainage far enough from well.
Gt. Barrington,	4,385	55	Spring-water from mountain.	No.	
Greenfield .	3,540	62	Aqueduct five miles long, from reservoir formed by damming Glen Brook.	No.	
Greenwich .	606	12	Wells and springs.	No.	
Groton . .	1,908	24	Wells.		
Groveland .	2,084	48	Wells.	No.	
Hadley . .	2,125	33	Wells.		

Halifax	568	6	Wells and springs.	No.	
Hamilton	797	9	Wells.		
Hampden[1]	1,008	7	Wells and springs.		
Hancock	730	7	Wells and springs.		
Hanover	1,801	30	Wells and cisterns.		
Hanson	1,265	15	Wells.	Think not.	
Hardwick	1,992	17	Wells and springs.	No.	
Harvard	1,304	27	Wells, springs, and private aqueducts.	No.	
Harwich	3,355	57	Wells and cisterns.		To a great extent cisterns are near sink-drains or low, swampy land. Wells are mostly tubular and deep, and not accessible to pollution.
Hatfield	1,600	24	Wells.		
Haverhill	14,628	328	Three ponds and a large well.		The water is excellent; much better than average.
Hawley	588	7	Wells and springs.	No.	
Heath	545	6			

[1] Adams has been divided into Adams and North Adams; Wilbraham, into Hampden and Wilbraham; Amesbury, into Merrimac and Amesbury. The populations of these towns have been estimated.

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Hingham . .	4,654	65	Wells and a few cisterns.		The wells are largely contaminated. An act has recently been passed by the legislature providing for a water-supply.
Hinsdale . .	1,571	23	Wells and springs.	No.	
Holbrook .	1,726	33	Wells mostly.		
Holden . .	2,180	33	Springs and brooks.		It is not in any great danger, nor is there danger at present.
Holland . .	334	5			
Holliston . .	3,399	83	Wells.	Yes.	The cause is cesspools, sink-spouts, and privies, in the immediate vicinity of the wells. The soil is becoming saturated with filth, as we have no system of drainage.
Holyoke . .	16,260	390	Deep natural ponds.	No.	
Hopkinton .	4,503	70	Wells and a spring.		
Hubbardston .	1,440	23	Wells and springs.		Our water-supply is good.
Hudson . .	3,493	56	Wells and cisterns.	Not with ordinary care.	In the compact parts of the town sewerage does not improve with the growth in other respects. Think there should be compulsory sewerage in all growing villages or towns.

Hull	316	12	Wells and cisterns.	Have not had any examined.	
Huntington	1,095	18	Wells and springs.	No.	
Hyde Park	6,316	82	Wells and cisterns.	Yes.	Wells are being affected by cesspools in some parts of the town.
Ipswich	3,674	69	Wells mostly.	No.	
Kingston	1,569	23	Pure springs, cisterns, and in the outlying districts by wells.		A few wells are theoretically in danger of pollution through the proximity of sink-drains, but there has been no exceptional ill-health in consequence to the families using them.
Lakeville	1,061	13	Wells.	No.	
Lancaster	1,957	22	Wells.		
Lanesborough	1,357	21	Wells and springs.	No.	
Lawrence	34,916	832	Merrimac River.		Polluted at Lowell, ten miles above.
Lee	3,900	64	Wells, many springs, and Laurel Lake; from which latter the town will soon be supplied.	Have no analysis of the waters.	
Leicester	2,770	52	Wells.	No.	
Lenox	1,845	25	Reservoir two miles from village, fed by springs.	No.	

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1875	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Leominster .	5,201	66	Public water-works supplied from an unfailing source among the hills.	No.	
Leverett . .	831	15	Wells and springs.	No.	
Lexington .	2,505	40	Wells.		
Leyden . .	524	8	Same as in all country towns.	Not aware of any danger unless from lead poison.	Many people get their water through lead pipes. Know of no complaints therefrom.
Lincoln . .	834	19	Wells principally. 13 families are supplied from Sandy Pond.	No.	
Littleton . .	950	15	Wells and springs.	Some wells are, no doubt, at times polluted.	
Longmeadow .	1,467	12	Wells.		If pollution occurs, it must arise from filtration from sink-drains or similar causes.
Lowell . .	49,688	1,088	Merrimac River.	No appreciable pollution.	
Ludlow . .	1,222	22	Wells.	No.	
Lunenburg .	1,153	18	Wells.	No.	
Lynn . .	32,600	627	Artificial ponds.	No.	In no danger of being polluted as it exists at present.
Lynnfield .	709	8	Wells.		

Malden	10,843	166	Spot Pond.	None known.	
Manchester	1,560	27	Wells, cisterns, and running brooks.	No.	
Mansfield	2,656	45	Wells.	No known cases.	
Marblehead	7,677	117	Wells and cisterns.		Too near privies, cesspools, &c.
Marion	862	10			
Marlborough	8,424	149	Wells.	Yes.	To some extent in our most thickly settled districts by surface water, and drainage from stables, pig-pens, and sinks.
Marshfield	1,817	32	Wells and springs.	No.	
Mashpee	278	6	Wells and cisterns.	No.	
Mattapoisett	1,361	18	Wells.		
Maynard	1,965	47	Wells.		
Medfield	1,163	24	Wells and cisterns.		
Medford	6,627	105	Spot Pond.	No.	
Medway	4,242	77	Wells and cisterns.	No.	And in no danger if properly cared for.
rose	3,990	55	Spot Pond.	Not to our knowledge.	
lon	1,176	20	Wells.	No.	

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Merrimac[1] .	2,100	36	Wells.	We think not.	
Methuen . .	4,205	62	Wells and cisterns.		
Middleborough,	5,023	72	Wells mostly.	Some are, and many in danger of being so.	From want of proper drainage.
Middlefield .	603	5	Springs of good pure water.		
Middleton .	1,092	12	Some are supplied by the Danvers water-works.	No, and in no danger as far as we know.	
Milford . .	9,818	170	Wells.	Yes.	Many of them give bad supply of water.
Millbury . .	4,529	91	Wells.		
Milton . .	2,738	32	Wells and cisterns.	No.	
Monroe . .	190	5			
Monson . .	3,733	82	Wells and living springs.		
Montague .	3,380	63	Wells and springs; a few from rain-water and river-water.		
Monterey .	703	5	Wells and springs principally.	No.	
Montgomery .	304	3	Wells.		
Mt. Washington,	182		Principally springs, some wells.	No.	

Nahant . .	766	8	Wells and cisterns.	No.	
Nantucket .	3,201	127	Wells.	No.	
Natick . .	7,419	136	Dug Pond; wells of brick or stone in some cases.	Possibly.[2]	A brook, dry most of the summer, flowing under one stable half a mile from its outlet, and with a few privies on its banks still more distant.
Needham .	4,548	63	Wells and a few cisterns.		
New Ashford .	160	1	Wells and springs.		
New Bedford ,	25,895	566	Storing reservoir by damming Acushnet River.	No, and in no danger so far as we know.	
New Braintree,	606	4	Wells.		
New Marlboro',	2,037	36	Wells and running water.	No.	
New Salem .	923	14	Wells and springs.	No.	
Newbury. .	1,426	20	Wells; in a few cases from springs.		
Newburyport .	13,323	260	Wells and cisterns.	Yes.	Our wells are in constant danger of being polluted by close proximity to privies and house-drainage. Still the city recently voted against the introduction of water-supply.
Newton . .	16,105	248	Collecting-basin, near Charles River.	No.	Excepting (?) from factories above us as alluded to in a report of the State Board of Health.

[1] Adams has been divided into Adams and North Adams; Wilbraham, into Hampden and Wilbraham; Amesbury, into Merrimac and Amesbury. The populations of these towns have been estimated.

[2] See also reply of medical correspondent.

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Norfolk . .	920	10	Wells.		Water good and at present in no danger.
North Adams,[1]	10,506	217[2]	A pure mountain stream.	No.	
North Andover,	2,981	43	Wells.		
Northampton .	11,108	140	Robert's Meadow Brook.	No.	
Northborough .	1,398	19	Wells and cisterns.	No.	
Northbridge .	4,030	85	Wells.	Yes, to a certain extent.	
No. Brookfield,	3,749	62	Wells.	No.	
Northfield .	1,641	27	Mostly springs and running water.	No.	
North Reading,	979	13	Wells.		
Norton . .	1,595	25	Wells.	No.	
Norwood . .	1,740	32	Wells and aqueduct.	In some cases.	
Oakham . .	873	22	Wells.	Yes.	No doubt some wells are polluted by stables, sink-drains, and privies.
Orange . .	2,497	42	Wells chiefly.		
Orleans . .	1,373	47	Wells and cisterns.	No.	

Otis . .	855	8	Wells and springs.	No.	
Oxford . .	2,938	47	Wells, springs, and cisterns.		
Palmer . .	4,572	87	Brought in cement and lead pipes from springs on the hills.		
Paxton . .	600	8	Wells.	No.	
Peabody . .	8,066	176	Brown's Pond.	Think not.	
Pelham . .	633	15			
Pembroke .	1,399	20	Wells.	Think not.	
Pepperell .	1,927	30	Wells.	No more than usual in country towns.	
Peru . .	443	9	Wells and springs.	Not generally.	May be in some cases where wells are in the immediate vicinity of hog-pens or water-closets.
Petersham .	1,203	20	Wells and springs.	No.	
Phillipston .	666	8	Wells, springs, and brooks.	Think not.	
Pittsfield . .	12,267	185	Ashley Lake and Sackett Brook.	No.	
Plainfield .	481	5	Springs mostly.	No.	
Plymouth .	6,370	118	Pond, six miles distant.	No.	
Plympton .	755	17	Wells.	No.	

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[2] Including Adams.

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
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Northampton .	11,108	140	Robert's Meadow Brook.	No.	
Northborough .	1,398	19	Wells and cisterns.	No.	
Northbridge .	4,030	85	Wells.	Yes, to a certain extent.	
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[2] Including Adams.

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Prescott	493	5	Wells and springs.		
Princeton	1,063	20	Wells and cisterns.		Generally good; greatest danger from wells and sink-drains.
Provincetown	4,357	69	Wells and cisterns.	No.	Unless too near privies.
Quincy	9,155	188	Wells.	No.	
Randolph	4,064	70	Wells.		
Raynham	1,687	25	Wells.		
Reading	3,186	51	Wells and cisterns.		Water generally good. No unusual danger of pollution.
Rehoboth	1,827	31	Wells and cisterns.	No.	
Revere	1,603	24	Driven wells.	No.	
Richmond	1,141	12	Wells and springs.	No.	
Rochester	1,001	18	Wells.		
Rockland	4,203	63	Wells and cisterns.	No.	
Rockport	4,480	77	Wells and cisterns.	No.	
Rowe	661	14	Wells and springs.	No.	

Rowley . .	1,162	16	Wells, and a small brook running through the centre of town.		The brook is fed by springs, very pure and nice.
Royalston .	1,260	16	Wells and springs.	Rarely if ever.	
Russell . .	643	12	Springs and wells.		
Rutland . .	1,030	15	Wells and springs.		
Salem . .	25,958	513	Lake Wenham.	No.	
Salisbury. .	4,078	66	Wells.		No more so than is likely from surface water.
Sandisfield .	1,172	13	Wells and springs.	No.	
Sandwich .	3,417	66	Wells, cisterns, &c.	No.	
Saugus . .	2,578	31	Wells, and Lynn water supply.		Wells are uncommonly good.
Savoy . .	730	6	Wells and springs.	Not much.	
Scituate . .	2,463	48	Wells mostly.		
Seekonk . .	1,167	20	Wells.		
Sharon . .	1,330	17	Wells, cisterns, springs, and aqueduct.	No.	
Sheffield . .	2,233	39	Wells.	No.	
Shelburne* .	1,590	20	Springs from mountain.	No.	

* Our medical correspondent reports contamination and occasional poisoning from lead pipes.

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

City or Town.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Sherborn . .	999	50	Wells.		
Shirley . .	1,352	19	Wells mostly, some aqueducts.	Not that we know of.	
Shrewsbury .	1,524	26	Wells, cisterns, &c.	No.	
Shutesbury .	558	8	Wells.		
Somerset . .	1,940	37	Wells, rarely from cisterns.		
Somerville .	21,868	367	Mystic Pond.		We think it is polluted.
South Abington,	2,456	35	Wells and a few cisterns.		
South Hadley .	3,370	54	From a brook and wells.		The running water is free from all impurities.
South Scituate .	1,818	44	Wells mostly.		Being from wells, there is not the danger of pollution as if from other sources.
Southampton .	1,050	22	Wells and springs.		
Southborough .	1,986	17	Wells.		
Southbridge .	5,740	83	Wells and cisterns.		
Southwick .	1,114	14	Brooks near village.	No.	
Spencer . .	5,451	170	Wells.	Not to our knowledge.	

Springfield .	31,053	462	Small streams supplying Ludlow reservoir.	No.	Except by vegetable matter consequent on its being quite new. Do not know that it is in danger of being polluted.
Sterling . .	1,569	23	Wells mostly.	Not that we know of.	
Stockbridge .	'2,089	28	Wells and mountain springs.		
Stoneham .	4,984	63	Wells.		Generally free from contamination.
Stoughton .	4,842	84	Wells.	In some cases.	By privies, and drainage from sinks and stables.
Stow . .	1,022	15	Wells.		
Sturbridge .	2,213	30	Wells mostly.	No.	
Sudbury . .	1,177	19	Wells.	Think not.	
Sunderland .	860	10	Wells and a few springs.	Think not.	
Sutton . .	3,051	68	Wells and springs.	No.	
Swampscott .	2,128	33	Springs and cisterns.		
Swansey . .	1,308	13	Wells and springs.	No.	
Taunton . .	20,445	378	Collecting basin and wells.	No.	
Templeton .	2,764	33	Wells.		
Tewksbury .	1,097	25	Wells.	Think not.	

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

CITY OR TOWN.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Tisbury	1,525	22	Wells and cisterns.	No.	
Tolland	452	3	Wells and springs.	No.	
Topsfield	1,221	20	Wells.		
Townsend	2,196	39	Wells.		
Truro	1,098	24	Wells and cisterns.		
Tyngsborough	665	12	Wells.		
Tyringham	517	9	Wells and springs.	No.	
Upton	2,125	29	Wells generally.	No.	
Uxbridge	3,029	63	Wells and springs.	No.	
Wakefield	5,349	92	Wells principally.		Some have bad water.
Wales	1,020	11	Wells.	No.	
Walpole	2,290	30	Wells.		
Waltham	9,967	171	Nominally Charles River, probably underground springs.	No.	
Ware	4,142	119	Wells, springs, and the river.		

Warren . .	[illegible]	[illegible]	Springs chiefly.	No apparent danger.	
Warwick . .	744	10	Wells and mountain springs.	No.	
Washington .	603	4			
Watertown .	5,099	75	Wells.	Very few complaints.	
Wayland . .	1,766	39	Wells, springs, and Rice's Pond.		
Webster . .	5,064	86	Wells, a few cisterns, and an aqueduct for fires.	No definite information.	Danger from want of care and means of proper drainage and sewerage.
Wellfleet . .	1,988	36	Wells and cisterns.		
Wendell . .	503	9	Wells.		
Wenham . .	911	24	Wells.		
Westborough .	5,141	69	Wells almost entirely. A public supply is to be introduced from a pond.		Quality varies with the season somewhat; generally good.
West Boylston,	2,902	54	Wells.		Generally good pure water.
W. Bridgewater,	1,758	26	Wells.		
West Brookfield,	1,903	26	Three aqueducts from springs.		
Westfield .	8,431	133	Two reservoirs supplied from mountain brook.	No.	

WATER-SUPPLIES IN MASSACHUSETTS — Continued.

City or Town.	Population by Census of 1875.	No. of Deaths, 1878.	Source of Water-Supply.	Is it Polluted, or in Danger of being Polluted?	In what way?
Westford .	1,933	32	Wells.	No.	Filter rain-water.
Westhampton .	556	13	Wells and springs.	Think not.	
Westminster .	1,712	28	Spring water.	No.	
West Newbury,	2,021	30	Wells and cisterns.	Not that we are aware of.	
Weston . .	1,282	13	Wells.		
Westport . .	2,912	53	Wells and springs.		
W. Springfield,	3,739	68	Reservoir supplied by living springs and streams.	No.	
W. Stockbridge,	1,981	28	Wells principally.	No.	
Weymouth .	9,819	130	Wells and cisterns.		
Whately . .	958	10	Springs, chiefly.		
Wilbraham * .	1,568	27	Wells, and aqueducts from private springs.		Some of the wells are no doubt polluted by their close proximity to privies and sink-drains.
Williamsburg .	2,020	28	Springs and wells. No public supply.		
Williamstown .	3,683	55	A mountain spring.		

Wilmington .	879	13	Wells.	No.	
Winchendon .	3,762	53	Wells and springs.	No.	
Winchester .	3,099	60	Storage reservoir.	No.	
Windsor . .	624	17	Springs mostly.	No.	
Winthrop .	627	21	Wells chiefly. To some extent from Boston water-supply.	Not in the village.	Danger from carelessness in regard to the wells at Ocean Spring.
Woburn . .	9,568	198	Horn Pond water-works.	No.	
Worcester .	49,317	946	Reservoir fed by Lynde Brook.	No.	
Worthington .	818	6	Wells.		
Wrentham .	2,395	32	Wells and springs.		
Yarmouth .	2,264	35	Wells and cisterns.	No.	

* Adams has been divided into Adams and North Adams; Wilbraham into Hampden and Wilbraham; Amesbury into Merrimac and Amesbury. The populations of these towns have been estimated.

NOTE. — The numbers of deaths given in the above table are as reported by the local officers, before revision in the office of the Secretary of State.

Our medical correspondents add their testimony as follows: —

Adams. — Typhoid-fever has been almost unknown in this village since the introduction of pure water and the general abandonment of well-water for drinking and culinary purposes.

Amherst. — There is danger of pollution to the water-supply from wells in the centre of the town, urgently demanding the building of a sewer.

Bedford. — Bedford Centre is on a low hill, and the ledge underlying it seems to conduct much surface-water tainted with privy and sewage matter into the wells, some of which are in the solid rock. On the slopes of the hill the houses along the two principal streets stand close, and the privies and drains of the upper houses taint those below. Mild forms of filth-diseases, catarrhal fever, headaches with disordered alimentary canal, and sore throats, are common.

Belchertown. — Our town is high, and mostly supplied by wells; no chance for pollution except by the neglect of parties themselves. There is a great deal of carelessness in regard to privies and drains; in many cases a circle of thirty or sixty feet would include all three, — not as bad, however, as a few years ago.

Berlin. — As to the pollution of water-supply, there is none except in a few cases of wells being contaminated by house-drains. No diseases have been traced to them the past year.

Boxborough. — There is danger in many of our private dwellings from near proximity to wells of sinks, cesspools, and privies.

Braintree. — The water-supply in this town is by wells; and, as population increases, the dangers from improper drainage increase, and to a greater extent than the inhabitants are willing to acknowledge. Many are in close proximity to cesspools, privies, and drains.

Brimfield. — Our people obtain all their water from wells, and there is no danger from pollution that the State can rectify. Many of the wells, however, are really polluted by the drainage of water-closets and sinks. This I consider a great evil, and a prevalent evil in country life; and it is hard to make the people realize the danger from such wells.

Brockton. — It was proved by analysis, and reported in the last State Board of Health Report, that our wells are all polluted to a greater or less degree by the various kinds of filth and *débris* which are deposited in door-yards, streets, gardens, and over the ground surface in general (there being no drain-pipes nor sewer conduits), and go with the rain where gravity and strata determine.

Chelsea. — In the year past there has been some complaint as to the purity of the Mystic water; but for the last six or twelve months there would seem to have been an improvement. I have been unable to trace or connect disease in any case as caused by the impurity of our water-supply.

Foxborough. — The water-supply is from wells. The danger of pollution consists in the vicinity to the wells, of the discharge of sewage from

the culinary operations and from the privies and cesspools in general use.

Gardner. — No danger of pollution of water-supply unless from cesspools, and not many cases of that kind.

Hadley. — Water from wells. Very common neglect to protect them from slops and other sources of impurity.

Hanover. — In some places wells appear to be in dangerous proximity to drains and sinks.

Hingham. — Water has not been introduced. We have our water usually from wells — in a few cases from cisterns of rain-water. An analysis of water of ten wells from different parts of the town, made three years ago, showed no generally diffused impurity. Some wells of good reputation were found impure. But no sickness has, either before or since the examination, seemed to follow the use of the water.

Lexington. — We have no common water-supply, but are dependent upon isolated wells, the security of which from ill-arranged sink-drains and privy-vaults, as relates to some of them, is more than doubtful.

Natick. — Our water-supply is from a pond, and since its introduction there has been a marked decrease of typhoid; and where it has occurred the supply of water has usually, if not in all cases, been from a well.

Newburyport. — We are dependent on wells and cisterns for our water-supply for domestic purposes, and we are in constant danger of the wells being polluted from the privies and sink-drains. Our great want is a good supply of pure water for domestic use.

North Reading. — Well-water is our only supply; and I know of many families who constantly use water contaminated by sink-drains, privies, barnyards, pig-sties, &c., and still they wonder why they have so much sickness.

Oxford. — Our water-supply is from wells, springs, and rain-water cisterns; and more is to be feared from contamination of the wells than from any other cause.

Princeton. — I think there is danger of pollution of wells of water from sink-drains and privies too near the wells.

Rockport. — Very many of the wells are in close proximity to stables and privies, and must from the nature of our soil be very much polluted.

Shelburne. — There is no danger of pollution or poisoning, except from lead aqueducts.

Southbridge. — Provisions of chap. 183 of Statutes of 1878 should apply also to natural springs, and sources of water-supply for families. In our own village, natural springs, the supply of many families, are now in danger of pollution from the sewage of dwellings erected on higher levels, and on land sloping towards the springs. There is no remedy apparent, except under the nuisance act, and this is of doubtful efficacy as a relief.

Taunton. — No danger from river-supply. Wells are generally polluted.

Tisbury. — I have noticed a few wells badly situated in relation to the drainage of slops, and other sources of impurity, but have not observed any bad effects from it.

Wakefield. — Our wells are horribly contaminated. . . . Our town has no water-supply. We have two excellent ponds (Lake Quanapossitt — two hundred and sixty-four acres, and Crystal Lake — forty-eight acres), and also an organized water corporation. Crystal Lake, our proposed future water-supply, is a sheet of water of great purity, and is not at present exposed to any special source of pollution. I had its waters, taken from a point near the centre of the pond and six feet below the surface, analyzed by Professor Sharples in May, 1877, and compared with the water of certain wells of the town, at the request of the Quanapossitt Water Power Company. The results, in parts per 100,000, are as follows: —

	Ammonia.			Organic and Volatile Matters.	Inorganic.	Total Residue at 212° F.
	Free.	Albuminoid.	Total.			
Crystal Lake water . . .	.0020	.0060	.0080	2.5	2.5	5.
Water from outlet of lake below town dam and rattan factory	.0040	.0070	.0110	[illegible]	5.5	8.5
Private well, good water .	.0020	.0050	.0070	11.5	20.	31.5
Private well, bad water . .	.0090	.0120	.0210	12.	59.	71.
Private well, bad water . .	[illegible]	[illegible]	.0468	34.	57.	91.
Town pump, in constant use .	.0010	0040	.0050	18.5	46.	64.5

The water of Lake Quanapossitt has been previously analyzed, and is not so good. It is also now subject to pollution by the presence of a gas factory and a fat-rendering establishment on its western tributaries, and also by the custom of depositing town-refuse near its southern and western shores.

Walpole. — Our water-supply is almost universally wells, on the premises of householders, and when they are polluted it is generally by the people themselves.

Prevalent Diseases, &c.

Three hundred and seventeen boards of health have replied to our circulars; and there were answers from our medical correspondents, representing one hundred and eighty-five cities and towns. From their reports it appears that whooping-cough has been quite prevalent, affecting adults to an uncommon degree; measles has been quite wide-spread in many towns, but often in a mild form; scarlet-fever has been severe only exceptionally; diphtheria was still prevalent, but

less so than for the previous two years. There was less typhoid-fever, commonly, than usual, attributable probably to the excessive rains of the early autumn; and for the same reason, perhaps, the soil was so saturated as to have caused the generally observed prevalence of rheumatism, influenza, and pulmonary diseases of the winter. A few cases of varioloid were reported in Revere, Richmond, and Rockland; and one of small-pox in Chelsea. Diarrhœal diseases were less fatal than usual.

With regard to the most highly infectious diseases, especially scarlet-fever and diphtheria, renewed and increased efforts require to be made in the way of isolation and disinfection before those diseases can fairly be said to be controlled, to the full extent of our knowledge of sanitary science. *Hospitals for people suffering from infectious maladies, disinfecting-furnaces, and laundries for washing infected underclothing, &c.*, are now largely in use in England and Scotland, with the result of so far diminishing the spread of infection that their use is strongly recommended by the Board here.

As boards are established more and more each year, whose exclusive duty it is to attend to sanitary matters, it is hoped that careful investigations and accurate reports will be made by them. The paper on the mortality of Boston, by Dr. F. E. Oliver, published in this report, is prepared on a plan which it would be desirable to follow, both for the sake of uniformity, and because of its excellent method. Of course, the results of sanitary inspections, &c., may be added.

The death-rates for the year, in the cities of the State, are as follows: —

CITIES.	Population by Census of 1875.	Estimated Population for July, 1878.	Number of Deaths in each.	Annual Death-Rate per 1,000.
Boston	341,919	356,500	7,677	21.53
Lowell	49,688	53,000	1,088	20.53
Worcester	49,317	52,000	946	18.19
Cambridge	47,838	51,000	964	18.82
Fall River	45,340	46,000	1,057	22.98
Lawrence	34,916	38,000	832	21.89
Lynn	32,600	33,000	627	19.00
Springfield	31,053	31,500	482	15.30
New Bedford	25,895	27,000	566	20.96
Salem	25,958	25,500	513	20.12
Somerville	21,868	23,200	367	15.82
Chelsea	20,737	20,700	352	17.00
Taunton	20,445	20,400	378	18.53
Holyoke	16,260	18,000	390	21.67
Gloucester	16,754	17,500	345	19.71
Newton	16,105	17,000	248	14.59
Haverhill	14,628	15,200	328	21.58
Newburyport	13,323	13,400	260	19.40
Fitchburg	12,289	12,400	162	13.06

The Secretary of State has requested the Board this year to edit the registration report of vital statistics. The communications bearing upon the locality and causation of diseases are as follows, beginning with Boston.

HEALTH OF BOSTON.

The returns of the City Register for 1878 show a somewhat increased mortality over that of the preceding year. The whole registered number of deaths for the year was 7,677, against 7,316 in 1877, this giving in an estimated population of 356,500[1] a death-rate of 21.53 to the 1,000 living. This mortality, although higher than in 1877, falls considera-

[1] The population has been estimated by calculations from the census returns of 1865, 1870, and 1875; by the births and deaths of twelve years past; by the yearly polls since 1865; and by the statistics of immigration and emigration.

bly below that of the mean death-rate of Boston for thirty years past, (24.50), and may still be said to be a comparatively low one, a result due in part to the continued mildness of epidemic influences, the clemency of the winter, and the greater sanitary precautions generally observed.

The following table gives the average number of weekly deaths, the average weekly and daily ranges of temperature, the mean temperature, the rainfalls and the prevailing winds, together with the mortality-rates of New York and London.

TABLE I. — *Deaths and Meteorology for 1878.*

	Average No. of Deaths Weekly.	Mean Temperature.	Average Daily Range.	Average Weekly Range.	Relative Humidity.	Fall of Rain in inches.	Prevailing Winds.	Deaths per 1,000 in 1878.	Deaths per 1,000 in 1877.	Death-rate in New York in 1878.	Death-rate in London in 1878.
Year	147.6	49.5	–	–	–	65.37	– –	21.53	20.72	24.78	23.43
First Quarter . .	134.	32.5	17.7	43.3	66.	17.92	W. and N.-W. .	19.53	19.52	24.93	25.60
Second Quarter . .	134.4	55.	15.3	30.7	68.9	9.46	W. and N.-W. .	19.61	18.27	23.36	22.50
Third Quarter . .	168.9	68.3	17.2	33.5	71.8	15.72	W. . . .	24.63	26.23	27.90	22.09
Fourth Quarter . .	153.3	42.5	15.2	33.2	69.	22.27	W. and N.-W. .	22.37	18.79	22.93	23.53

It appears from the above table that in the first, second, and fourth quarters of the year, the average weekly number of deaths was higher than in 1877, the difference being especially noticeable in the fourth quarter, in which diseases of the respiratory organs were unusually prevalent. In the third quarter, the period generally of the highest mortality, the weekly average was ten less than in the previous year.

The meteorological tables furnish little that is especially noticeable. The mean temperature for the last quarter of the year was somewhat lower than in the corresponding period of 1877, 42.5 against 44.2; and the rainfall during the same period was more abundant, 22.27 inches against 19.78. The rainfall in the third quarter was also much greater than in the previous year, the whole amount for the last six months of the year having measured more than ten inches in excess of that of the same period in 1877.

The diseases that principally contributed to swell the mortality-rates were diphtheria, cholera infantum, and diseases of the respiratory organs; the latter having been especially prevalent during the year.

Among the principal diseases of the zymotic class, measles was unusually active. The deaths, which were but two in 1877, rose to 103, the largest number from this disease for the past twenty-five years, making 1.39 per cent of the whole mortality. The disease was most fatal in July, when the number of deaths reached nearly that from diphtheria.

Scarlatina was far less fatal than in the previous year, causing only 69 deaths against 104. The yearly average mortality from this disease for the previous ten years was 300. The largest mortality was in the last quarter. It is reasonable to suppose that the sanitary precautions insisted upon by the City Board of Health and municipal authorities have had a positive effect in limiting the ravages of this disease.

The deaths from diphtheria, which had declined from 575 in 1876 to 361 in 1877, again rose to 456 in 1878, its prevalence increasing as the year drew towards its close.

Croup also proved more fatal than in the previous year, there having occurred 128 deaths against 97.

From cholera infantum the deaths were 394, which were nearly two hundred less than in 1877.

The deaths from all diarrhœal diseases, including cholera infantum, were 771 against 913 in the previous year, making 10.04 per cent of the whole mortality.

From typhoid-fever, the tables show a decline from 156 deaths in 1877 to 120 in 1878, or 1.56 per cent of the whole number.

The deaths from all zymotic diseases, to which more than one fourth part of our mortality is generally due, were 1,956 against 1,714 in 1877, making 25.49 per cent of the whole.

The mortality from phthisis, although somewhat above that of 1877, still continued below the average of past years, the percentage of mortality to the whole having been not far from that of 1875. It was stated in our last report, that the lessened immigration may have in some degree influenced this result in 1878; and it is by no means improbable that it still affects the death-rate from this disease, which, if the

latter year be excepted, has steadily declined since 1875, falling from 3.86 in that latter year to 3.52 in 1877, and again rising in 1878 to 3.88 to the 1,000 living.

Pneumonia was far more fatal than in 1877, causing 7.68 per cent of the whole mortality, against 6.12.

Bronchitis also was more prevalent than in the preceding year. The rise in the death-rate from these three diseases commenced early in the year, and continued uniformly higher until its close.

The reported deaths from violence were 287 in number, 35 of which were by suicide, and 17 by homicide.

The following table gives the deaths for each month, and the comparative rates from the diseases specified.

TABLE II. — *Mortality of Boston in 1878.*

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total Deaths.	Per cent to whole mortality.	Deaths to 1,000.
Total Deaths	592	520	627	582	590	577	797	772	627	663	624	706	7,677	–	21.53
Total Zymotics	119	76	102	90	124	135	320	363	228	169	104	126	1,956	25.49	5.37
Principal Zymotic Dis.: Small-pox	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Measles	–	–	–	12	22	26	32	4	–	4	1	2	103	1.39	0.28
Scarlatina	7	7	4	8	1	4	3	3	–	7	11	14	69	0.89	0.19
Diphtheria	55	38	44	24	29	50	39	25	28	42	33	49	456	5.93	1.27
Croup	10	7	12	9	15	9	6	2	4	17	18	19	128	1.66	0.35
Whooping Cough	11	3	5	1	8	3	11	19	13	4	7	7	92	1.19	0 25
Cholera Infantum	–	2	3	2	2	6	134	153	66	22	3	1	394	5.13	1.10
Diarrhœal, Total	8	7	10	8	18	15	191	279	146	69	12	8	771	10.04	2.16
" 5 years, and under	3	3	4	5	9	13	172	232	136	62	13	7	659	8.58	1.85
Typhoid Fever	15	4	8	9	11	11	10	13	13	8	9	9	120	1.56	0.33
Marasmus	7	10	25	15	15	14	15	21	20	25	14	20	201	2.61	0.56
Phthisis	141	89	129	135	105	106	86	98	94	129	122	150	1,384	18 02	3.88
Pneumonia	61	65	62	73	49	43	32	23	22	35	49	76	590	7.68	1.65
Bronchitis	21	25	25	20	16	12	16	10	14	26	37	34	256	3.33	0.71
Suicide	4	1	4	4	3	1	3	1	3	3	4	4	35	0.45	0.09
Homicide	1	1	3	–	1	2	3	1	2	1	–	2	17	0.22	0.04
Total by violence	29	10	25	20	21	21	53	17	24	29	20	18	287	3.73	0.80
Institutions	77	77	84	89	66	67	84	59	71	72	62	63	871	11.34	2.44
Under 1	88	116	115	107	125	95	201	303	184	179	138	105	1,756	22.86	4.92
5	274	306	323	303	246	209	356	480	295	307	223	198	3,520	45.85	9.87
Over 70	72	82	71	66	65	43	52	58	56	69	75	82	791	10.30	2.21

It will be noticed from the above table, that the deaths under one year of age show a further decline in infant mortality from that of the previous year; while the deaths of children under five years of age were more than in that year, making 45.85 per cent of the whole mortality. The returns from St. Mary's Infant Asylum are far more favorable the past year, than before ; a result due, says the Report of the Board of Health, "to a less crowded condition, and to the generally improved sanitary management of the home."

This decline in infant mortality, which for many years has been so excessive, equalling that of the most unhealthy English towns, whatever may be its cause, is certainly an encouraging fact. The average mean ratio of deaths under one, to births, for the five years previous to 1878, was 19.2 per cent. The ratio for 1877 and 1878 was 17.2 and 17.3. The decline in the percentage of deaths under one, to the entire mortality, is equally suggestive, falling from 25.41 — the average percentage for nearly thirty years past — to 22.86.

The following table gives an approximate estimate of the population and death-rates in the twenty-five wards.

TABLE III. — *Boston — Population, Area, and Deaths per 1,000, in the Different Wards in 1878.*

	Ward	Population.	Acres.	Population per Acre.	Death-rate in 1878.	Death-rate in 1877.	Death-rate in 1876.
I.	1	14,519	1,099.75	13.21	20.45	15.16	17.7
II.	2	16,089	449 87	35.76	18.14	20.46	19.8
	3	11,642	170.	68.83	22.09	17.87	
III.	4	11,629	242.	48.05	16.33	18.06	20.0
	5	11,718	130 75	89.62	22.10	18.27	
IV.	6	18,413	139.	132.46	25.30	22.65	18.2
V.	7	12,968	65.69	197.47	24.65	22.27	23.9
VI.	8	12,613	48.	262.75	26.56	22.90	23.9
VII.	9	13,114	81.	162.45	18.76	19.11	26.1
	10	10,875	94.	115.64	12.04	14.20	
VIII.	11	14,449	470.33	30.71	14.32	12.93	14.1
IX.	12	15,476	146.	106.	21.32	22.57	26.1
X.	13	22,607	228.	99.13	26.01	21.30	27.9
XI.	14	19,497	518.	37.63	17.43	14.71	20.9
XII.	15	14,354	429.	33.41	17.75	17.08	22.3
XIII.	16	15,282	64.25	23.78	18.38	18.30	19.4
XIV.	17	14,323	102.60	139.60	13 33	14.24	16.3
	18	13,612	100.70	135.01	14.62	11.27	
XV.	19	19,492	148.60	131.19	21.49	20.09	22.3
	22	15,994	666.	24 01	15.13	17.79	
XVI.	20	12,028	636.60	28.89	24.94	18.70	20.5
	21	12,465	10.80	11.54	14.19	22.28	
XVII.	23	12,841	63.86	2.01	13.93	19.82	17.6
XVIII.	24	14,036	47.62	2.94	15.68	17.42	21.2
XIX.	25	6,464	23.43	2.75	17.01	15.93	15.8
		356,500	20,581.12				

This table shows that the highest death-rates were, for the most part, in those wards that have before been characterized by insanitary conditions and often by an overcrowded population. The largest mortality was in Ward 8, where the death-rate was 26.56 per thousand, and the population 262 to the acre. The other wards where the death-rate was excessive were the fifth, sixth, seventh, thirteenth, and twenty-first.

In connection with the mortality in East Boston, "a point of special interest," says Dr. Leonard, "relates to the diarrhœal diseases. Of the eighty-four deaths recorded from those diseases, forty-five were from dysentery, and twenty-nine from cholera infantum. Most of these cases occurred in the lowlands, in the region of Porter Street, between July 25 and Sept. 10. The sewers in this region were found obstructed by deposits." The latter being removed, and the sewers flushed, no death was subsequently reported from either of these diseases. Dr. Leonard is unable to account for the increase of diphtheria and acute pulmonary diseases.

In allusion to the general sanitary condition of Boston, the City Board of Health in their last report mention the foul odors that have been complained of at times in nearly all parts of the city, but more especially by inhabitants of the South and West Ends. These are attributable to accumulations of sewage upon the flats in and about the city, which is rapidly increasing. The measures already taken for filling the Roxbury Canal, and providing for a more complete system of sewerage, will aid at least in relieving Boston of an evil that no great city in this age should be obnoxious to. Beside these familiar stenches should be mentioned those not less offensive and unwholesome that arise from various establishments for carrying on noxious and offensive trades. 'Notwithstanding, however, those many insanitary streams that invade on every side, the health of the city for the past two years has been almost unprecedented; and its continuance will depend much upon the well-directed efforts of the sanitary authorities.

Abington. — Five cases of typhoid-fever occurred in one house, traceable to the leakage of a privy-vault into the well; all except one, which did not prove fatal, however, running a mild course.

Adams. — Diphtheria was confined to one locality; the cases, fourteen in all, occurring within two weeks and among French Canadians; filthy surroundings, want of proper ventilation, and general "nastiness," being the rule amongst them. No cases have occurred since the time noted.

Ayer. — Scarlet-fever has occurred in rather a mild form and in isolated cases through the year, perhaps not in two families at one time; in a majority of cases affecting only part of a family. This was the case in 1877. There would seldom be apparent connection between cases, except in house mentioned last year, where there was a young man moved into family in spring of 1878, four or five months from occurrence of last cases, and had a well-marked attack of scarlet-fever. Diphtheria during first quarter was quite fatal. It occurs as last year in all parts of the town, regardless of location seemingly: there have been some severe cases in well-lighted, ventilated, and drained houses, located on high, rocky oak land, and with good surroundings.

Boxborough. — More than any other source of disease seems to me to be the insufficient care of cesspools and privies in and about many of our dwellings. Contamination of air and water through this difficulty, in my opinion, causes more diseases than all other outward causes combined. I think there should be a commission in all our districts to examine all our dwellings, and give directions about them.

Brookfield. — This town has generally suffered more from fevers of a typhoid character than others differently located. The meadows lying to the south and south-west of the town, which after heavy summer rains drain and dry slowly, are popularly supposed to account for the frequent cases of the above.

Carver. — Typhoid-fever attributed to want of care of privy-vaults at the boarding-house for the mill-operatives.

Chelsea. — Our sewerage is not satisfactory, but no disease can be said to have resulted from the gases. Our city government have taken steps for quite an extended improvement in this direction.

Chester. — Rheumatism always prevalent; due to locality and damp dwellings, some of them built on springs of water, &c.

Everett. — The drainage of this town has been much improved by culverts and asphaltum prepared gutters. Only one sink-drain opens on the open street, and our board of health have not yet abated the nuisance: I have often called their attention to it. The privy-vault reported a year or two ago has been improved, and now is drained under ground, many feet away from the artesian well.

Fairhaven. — Dysentery commenced in a house on the north side of a fresh-water pond (formerly salt water). Situation low, with pig-pen, privy, and sink-hole all near the well of drinking-water. The first patient, a child of seven years, was taken Aug. 8, and died on the 21st. Soon the mother was attacked, followed by several other members of the family. The mother of the first patient, after suffering severely with dysentery about ten days, showed unequivocal symptoms of diphtheria, and was a long time sick. On Sept. 9 two children in a family on the south side of the pond, a distance of about an eighth of a mile, were attacked with diphtheria. At this time there was not another case in town. On recovering, these children went to school Oct. 2. A child sitting near them was attacked with diphtheria, went home, and in a few days communicated the disease to other children in the family, two of whom died of diphtheritic croup. The disease spread through the village; ten or twelve died. All cases were directly traceable to the first cases of diphtheritic dysentery.

Fitchburg. — A larger number of cases of typhoid-fever occurred at West Fitchburg than in the remaining portions of the city in proportion to the population, and they were usually more severe; but I am not aware of any thing in the sanitary condition of the locality to account for it. Diphtheria is represented as slightly prevalent most of the year. Though but few severe cases have occurred, it has appeared that many of the cases and the most severe ones have been in the vicinity of a small stream or rill running through the central portion of the city, called Punch Brook, a receptacle of the deposits of a number of privies, and

nearly dry in the summer. The city is authorized to use this stream as a sewer, but as yet has only improved the lower portion of it.

Gardner. — Diphtheria was brought into this town three times last winter; the first in December, 1877, confined to one family, one death; the other two in January, 1878. One of these was confined to one family with a single death; the other spread somewhat, — twenty cases or more, and six deaths.

Groveland. — Diphtheria was confined to South Groveland. I have had over a hundred cases under my own care, and fourteen deaths. Should judge there had been a hundred and twenty-five cases and twenty deaths in all; but, as a number have been under the care of out-of-town physicians, cannot tell exactly. Can imagine no reason why it should be more prevalent there this year than any year before. Last year we had it in the north end, but none at all this.

Haverhill. — Diphtheria has continued to be the prevailing disease in our city during the past year. We have not been exempt from the disease in some form during any portion of the year. The cases have been sporadic, occurring in different parts of the city, and the fatality has been large in proportion to the number of cases. It is difficult to detect local causes. The most airy and dry localities are invaded, while the more densely populated portions of the city have been comparatively exempted. We have not been able to trace the disease as the result of *direct* contagion to any extent. Our city is exceptionally well drained for a small town, and we have good plumbers to attend to piping our dwellings.

Huntington. — The continued stringency of the times has given the employed a considerable time in open air, which has been for their health.

Lynn. — The mortality in Lynn during the past year has been rather less than usual. Estimating the population at 34,000, the death-rate for the year is 18.3. None of the principal zymotics have caused the average amount of mortality, except diphtheria and croup. The two mentioned have caused together fifty-six deaths, distributed as follows: twelve in the great valley occupied by Stacey's Brook and the chain of ponds; sixteen in the section bounded by Market Street, Summer Street, Western Avenue, and the marsh; twelve in the valley of Strawberry Brook and branches; four close by the harbor; six in the vicinity of Acorn and High Rock Streets; the rest scattered about, but nearly all in the localities previously invaded. The disease has followed the same general laws of prevalence and fatality as in the two previous years (see Reports for 1876 and 1877). The damp and otherwise unhealthy sections of the city have suffered by far the most severely. The place upon the hill where the deaths occurred (four from diphtheria, and one from croup) is wet from defective drainage. There is a rocky basin at the foot of Acorn Street which holds the water, making the street at times impassable. The soil is shallow, overlying rock; and many of the houses, although of fair exterior, are very defective in a sanitary point of view. Diphtheria occurred here in 1876. "Croup" occurs everywhere in connection with diphtheria, and there alone. The following relation will

illustrate the interdependence or identity of the two diseases, or the difficulty of differential diagnosis between them. A and B are brothers, and have each three small children. They live about half a mile apart, in a section where diphtheria has prevailed to a considerable extent. A's children are taken with membranous croup (so called by the attending physician) and all die. The physician assures them that "croup" is not contagious, and allows B's children to visit at A's house, and even to sleep with their sick cousins. Shortly afterwards (about a week) B's children are taken sick with diphtheria, the same physician attending, and all die. The three former deaths appear in the records as from croup, and the three latter as from diphtheria. Does any one doubt their identity? B's children *may* have acquired the disease in some other way than by contagion from A's; but they were taken sick so soon after their exposure, that it seems, to say the least, a curious coincidence.

As an interesting fact bearing upon the infectiousness of diphtheria, it may be mentioned that a tenement in the eastern section of the city was occupied during the same season, in succession, by three families, one after another of which was affected with diphtheria. The house is old, and the drainage bad.

Typhoid-fever has been much less prevalent and fatal than in former years before the introduction of pond-water. The statistics show a marked decrease. No decisive action has been taken by the city in relation to an improved disposal of sewage; and the harbor continues to send forth from its stinking bottom the most abominable odors during the hot months. Those who live near can bear witness to the yearly increase in the intensity of these odors. The water supplied to the city has been, for the most part, of a satisfactory quality. Late in December, however, many complained of a bad smell and taste in the water. It appeared on investigation that this was observed in some houses, and not in others near, nor in the ponds. Hence it was concluded that it arose from an accumulation of organic material in certain of the pipes. "Blowing out" the hydrants seemed to remove the difficulty.

No steps have as yet been taken towards the establishment of an independent board of health. In their lukewarmness on this supremely important question, the people of Lynn are manifesting a spirit quite in contrast with that which they display in relation to other matters which vitally concern their interests.

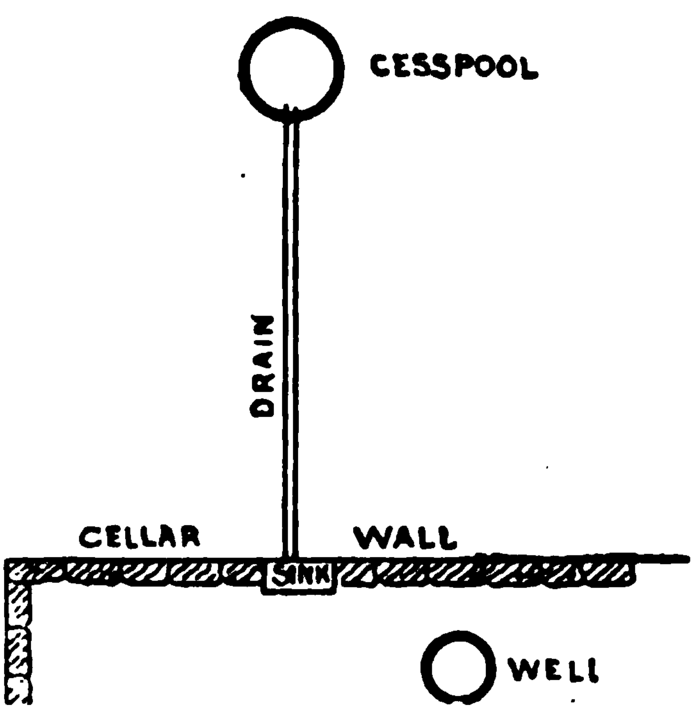
Millbury.[1] — About a year ago my son, thirteen years old, was taken sick with diphtheria. It was quite a severe case, and was very obstinate, resisting, day after day, all treatment. Medicines did not have their usual effect. By and by we thought of the water, and immediately sent two quarts of it to Dr. Hayes for analysis. He sent me the following statement: "It has the character of a naturally pure and good water, but contains animal matter (nitrates, nitrites, ammonia, and chlorides) like that found in drains and cesspools. The quantity is small in actual weight, but is sufficient to render the water, at least unwholesome, if not

[1] Not from our regular correspondent.

positively dangerous." We immediately stopped using the water, concluding that the impure water was the probable *cause* of the boy's sickness and the probable reason why the medicines would not work; for they had been mixed in this water, and he had used it for a gargle. With *change of water*, the sick boy at once began to mend, and was soon about the house again. This was the *third* case of diphtheria we had had in our family within the space of some two years, and the only cases in the neighborhood, which led us to suspect something was wrong.

I had myself been subject to a chronic irritation in my *throat*, often amounting to soreness and serious trouble, and also to frequent attacks of *diarrhœa*, especially through the warm weather; but for a year past, or *since we ceased to use that water*, I have had no trouble worth speaking of, in either of these ways.

The well is in the cellar, almost directly under the sink, three feet only to the right of it. The top of the well is two and a half feet from the cellar-wall. The drain, originally of plank, was sixteen feet long, so that the cesspool was within seventeen or eighteen feet of the well. But this was not the worst feature of the case. This plank drain, after a time, rotted away, so that the filthy water began to soak into the ground just outside the cellar-wall, and within six or eight feet of the well and *almost* directly above it. The earth, when we removed it to lay a new tile-drain, was *good manure* as deep down as we dug, and I know not how much deeper.



The water looked *clear* except just after heavy rains, and had no ill smell or ill taste about it. We now use cistern-water, and leave the well untouched.

Marlborough. — When we have a dry season, and the springs become low, I have noticed a prevalence of typhoid diseases in a section of the town where a ledge of rock underlies the surface. This ledge crops out of the ground at intervals, but has an average depth of perhaps twelve feet. The drinking-water of this section is taken from wells sunk down to the surface of the rock, and very quick to respond to a sudden rain, and consequently liable to be contaminated by surface drainage.

Mattapoisett. — Our little village and town is a remarkably healthy locality. Some thirty years ago it was very unhealthy, and about that time a swampy tract of land was cleared and drained. A few feet under this lies a gravelly stratum with iron so as to form what is known here as "pan."

Newbury. — There were seventeen cases of typhoid-fever, four of which were fatal. A great deal of fish-offal had been used as a manure in the neighborhood of these cases.

Newton. — Dysentery prevailed quite generally through the whole

town, during the past summer, of a severe type; and most of the cases in this vicinity were among the poorer classes as usual, and among those whose water-supply was from wells, in most cases not deep, and on unaccepted streets where the water of the city works had not been carried. The soil was loose, gravelly subsoil, but low, with standing water all about. This applies especially to this part of Newton, though in all parts of the town, as I have said, it prevailed, but more among those whose water was from wells.

Northampton. — This town, with an excellent supply of pure water, has no system of sewerage; and in summer the sewage from the houses, cesspools, and barnyards may be seen flowing through the gutters in thickly populated streets, or stagnating in pools within a few rods of dwellings.

Orleans. — Diphtheria broke out in February in the north-west part of Orleans in a house with a lot of decaying potatoes in the cellar, which were picked over by a girl some ten years old. This girl was the first to have the disease, and died. Every member of the family had it, and one other died. From this it spread by well-marked contagion. Nearly all the typhoid-fever was immediately around a small pond and cedar-swamp near the line of Orleans and Eastham. I had seventeen cases (with two exceptions) within an eighth of a mile of said swamp and pond, and know of eight other cases in the same locality. Several cases were of more than average gravity, two of which proved fatal.

Pembroke. — The cases of scarlet-fever have been mild and largely sporadic. I am not fully convinced of its great communicability by clothing, &c., as so much declared by many writers now. A very large proportion of the cases that I see are isolated cases, spreading through a family, it may be, as typhoid-fever sometimes does, but not through a school or a neighborhood. Nor am I convinced that these diseases are so largely owing to filth or filthy surroundings, although I believe that cleanliness is next to godliness.

Our supply of water comes almost wholly from wells, some of these, it may be, in dangerous proximity to sink-drains and privies. The drainage is altogether surface drainage. The autumn was very dry, so that many of our ponds and our meadows were dried up, and in a condition to give off malaria from decayed vegetable matter: still not a case of malarial disease.

Plymouth. — Whooping-cough prevailed in spring, of a mild form, and was followed by an extensive epidemic of measles during the months of May, June, and July, which visited the schools of the northern and central portions of the town. Of nine hundred and eighty pupils, four hundred and eighty-seven had the disease, or nearly fifty per cent. There were probably seven hundred or eight hundred cases in the town, with not a single death.

Reading. — In five houses near each other, containing about twenty-three inmates, there occurred sixteen cases of dysentery, ten of which were of a marked typhoid or malignant type, and six of them fatal. In one of these houses all the sink-water collected, unknown by the inmates, directly under the kitchen floor, forming a putrefying cesspool. Six persons lived here. All had dysentery: two, children, died; one,

their mother, was dangerously sick; the rest had attacks of moderate severity. Those who had the lighter attacks were those who were away much of the time; and those who had the severe and fatal attacks lived much in the kitchen. In the second house all the five inmates had dysentery, and three died, two children and their grandmother. The sink-drains were offensive, with nothing to prevent the entrance of their gases into the house. In the third house no glaring sanitary defects were found. A woman who had helped take care of the sick in No. 2 had the disease, and died of it; her boy also had it; the husband escaped. The condition of the fourth and fifth houses I do not know so much about. The former is about thirty feet from No. 2, and had two or more severe cases. No. 5 had one. The well-water used by these families was examined by Professor Sharples, who failed to find in it any thing suspicious. Several cases of a similar malignant type, two of which were fatal, occurred at considerable distances from this neighborhood, where, so far as I know, no sanitary defects were found.

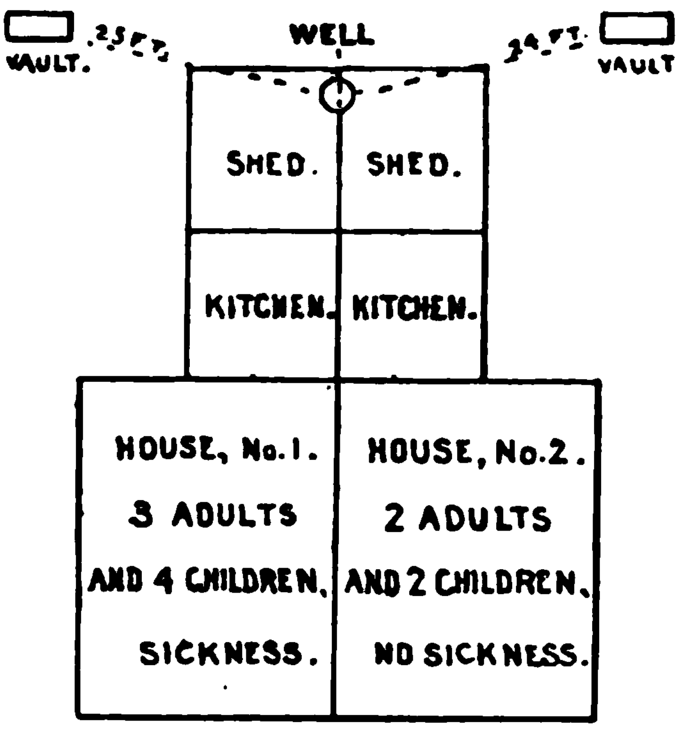
Revere. — The diagram illustrates the association of a marked amount

Well Water in Revere.

[Parts per 100,000.]

	Ammonia.	"Albuminoid Ammonia."	Nitrates.	Chlorine.	Solid Residue.		
					Inorganic.	Organic.	Total.
1	.0160	.0160	Distinct . .	Present,	15.	15.	30.
2	.0096	.0128	Distinct . .	Present,	10.	8.	18.

of illness, attributed to the use of contaminated drinking-water. As may be seen, the well is within twenty-five feet of two privy vaults. The chemical analysis by Professor Sharples shows the water (No. 1) to be largely polluted. No. 2, from the stable-well, used for a short time, is less fouled, although not safe for domestic use. The occupants of house No. 2 almost never used water for drinking, except after it had been boiled. They remained free from illness. The father and three children in house No. 1, where the well-water was used for drinking-purposes, were quite ill with symptoms referable to the digestive system, — fever, nausea, headache, &c.; while the fourth child, without traceable exposure to a previous case, became ill with scarlet-fever, and had an undue amount of nausea and vomiting, which had apparently been caused by



the impure water. After repeated illnesses, Dr. Ross suspected the water, and sent specimens for chemical analysis. After giving up its use, the various members of the family became immediately well, and have remained so.

Sterling. — Typhoid-fever cases few, and very fatal. Every case occurred in the hills away from the village; and the only cause I could find was a nearness of barn-yard, and deposit of sink-water on surface.

Sutton. — All the deaths by typhoid-fever occurred at Manchaug, a cotton-manufacturing village. The operatives live in crowded tenement-houses; sink-spouts empty on surface, not far removed from wells; privies sometimes too near wells; habits of occupants not cleanly.

Taunton. — The epidemic of diphtheria in Westville, a factory village two miles and a half out, was very severe, taking all the children and many adults. It began among the school-children, and may have been caused by the impure well-water. For a long while, only scholars were attacked: two, aged twelve and thirteen years, died.

Wakefield. — We are still reaping, in continual diphtheria and typhoid-fever, those results which we may increasingly expect from our crowded territory and utter want of good water and drainage. Until some good general system of water-supply (at least) and further, but less imperatively, of drainage, is established here, we shall annually show (meteorological governings excepted) a heightened disease and mortality record.

The principal item to be noticed is the prevalence of diphtheria, for which I can assign no cause. The sanitary condition of the town is not peculiarly bad, and many cases occurred in localities which were otherwise healthy. There have been in all ninety-eight deaths in Wakefield in 1878; of which thirty-three, or 33.6 per cent, were from diphtheria. Diphtheria has been more or less prevalent since July, 1874. Between July 10, 1874, and Oct. 10, 1875 (nine months), there were twenty-five deaths from the disease.

Watertown. — There is but one positive fact that has forcibly impressed me, and that is, an unusual number of cases of dysentery, a disease scarcely known hereabouts for several years, which appeared in the month of September; attacking only young persons, severe in its symptoms, slow in progress, tedious in convalescence, but, as a rule, terminating in recovery. The cases had a pretty wide geographical distribution.

Webster. — There is a great indifference among many of the people of the town to the sanitary condition of the surroundings of their dwellings; and it is hard to make them see the necessity of taking proper measures to protect themselves from sickness which may arise from carelessness and neglect. In many parts of the town, drainage is wholly neglected, especially among the French Canadians, Germans, and other foreign people. The expense of improvement is a great factor with some men, — the increase of *taxes*, the great bugbear with those who go to the town-meetings, and do a great deal of talking, and are all the time calling loudly for retrenchment, and say there is no need of this or of any outlay, that the town is well enough as it is, it is as good as it used to be, and why the need of having it any better?

Westborough. — Diphtheria here; and there always was good reason to suspect imperfect drainage or bad water.

West Brookfield. — Typhoid-fever commonly attributed to stagnant water.

West Springfield. — Diphtheria severe in that part of the town nearest the rivers.

Wilmington. — The three cases of typhoid-fever were of a mild type, and probably caused by offensive well-water. In the months of September and October, diarrhœal diseases prevailed to some extent. Some occurred in well-to-do families, yet most of the cases were in indigent families, where they were allowed to eat and drink every thing, and to sleep in rooms which were damp. One case of malarial fever occurred in the month of June. A Frenchman employed on the Mystic Valley Railroad had been at work in a ditch when the disease showed itself. The patient stated that he had had the same disease last spring while at work digging a wet cut on another railroad.

Winchester. — So far as my own experience and that of my fellow-physician in town goes, I can trace no causation in diphtheria except contagion, which often seems very plain. I observe that children who have habitually enlarged tonsils are liable to a severe form if they have it at all. I find it hard to draw the line between diphtheria and tonsillitis, although *typical* cases are distinct enough. No other epidemic has ever prevailed here since I have known the town (fourteen and one-half years), to half the extent which influenza has twice had. None so affects all ages, or shows so little tendency to afford immunity from a second attack. Seventy-two cases of diphtheria are known to have occurred during the year, of which eleven proved fatal. The premises where sixty of these cases occurred were closely examined without detecting any unsanitary conditions; in two others, ground-water makes an unsanitary condition; in two others, sink-slops thrown or run on surface, but without bad smell, and no escape into cellars. It is believed that the disease has been spread by contagion, and that, *outside* the households where cases were in progress, the disease was spread by mild cases which never came under medical notice, and were never confined to the house. Among the pupils of one school situated on soil of deep sand and gravel, privies and ventilation good, teachers intelligent and awake to importance of ventilation, &c., within three weeks, nine cases occurred which were under medical treatment (and probably nearly as many others never seen by physicians): two of these were fatal, both in girls under ten years old.

CIRCULAR[1]

FROM THE

STATE BOARD OF HEALTH.

Drainage, etc.

Local boards of health are reminded that, at this time of the year particularly, special attention is required to secure cleanliness about dwellings and throughout towns.

No decaying matter should be allowed in cellars. On the contrary, they should be kept sweet and clean, and as much exposed to fresh air and sunlight as possible. They should also be made dry, by draining if necessary. It should be remembered that the air of houses is supplied largely from cellars; so that the common practice of storing all sorts of rubbish there should be condemned. If the air of the cellar is impure, it often gives rise to various ailments in the persons breathing it in the rooms above; and not seldom becomes one predisposing cause of such diseases as typhoid-fever, diarrhœa, dysentery, cholera infantum, diphtheria, scarlet-fever, sore throats, and numberless conditions of ill health which cannot be described under any particular name. If the air in the cellar is damp, neuralgia, rheumatism, and affections of the lungs and other respiratory organs, are very apt to follow.

The air supplied to furnaces should never be from cellars, but from *the outside atmosphere*, and, if possible, on the sunny side of the building. This is a very important matter in schools, where there would generally be no difficulty in

[1] Sent to physicians throughout the State, and to all the local boards of health, April, 1879.

following the best methods. The air-supply should *never* be drawn from shady back-yards, or the vicinity of privies, sink-spouts, &c.

If kept clean, ashes may be used to advantage in filling up low spots of land, making paths, &c.

Garbage should never be allowed to accumulate: all that is not fed to fowls or animals on the place should be kept in tight receptacles, and carried away frequently. Pig-pens should not be permitted in thickly settled places.

There should be no soakage into the ground near wells or houses permitted from stables and barns. It will often be found economical to save all the manure, liquid and solid, by receiving it in water-tight vessels, &c., or mixing it with loam, under cover, and frequently carting it away.

Chamber-slops, and slop-water generally, should never be thrown on the ground near houses. They may be placed directly on the soil of gardens, &c., or pumped up from water-tight cesspools, or be used by distribution under the surface of the soil, in the manner described on p. 334 of the Seventh Annual Report of the State Board of Health,[1] and now introduced in the town of Lenox, Mass. The chamber-slops alone can be easily disposed of by mixing them with ashes or loam, as at the Pittsfield Hospital, by the method shown on p. 87 of the Ninth Annual Report of the State Board of Health. If the kitchen-slops are discharged directly into a cesspool, care should be taken that the pipes do not get clogged with grease.

Earth-closets serve a good purpose, particularly for sick people and invalids, if *carefully attended to*, and if well-dried loam be used for them in sufficient quantity: they are more easily managed if liquid refuse be kept out of them.

The ordinary privy should be abolished. It is dangerous on two grounds. 1st, It must be so far from the dwelling as

1 These reports may be found in the town libraries, by applying to the selectmen, and in the various public libraries.

to seriously expose children particularly, during bad weather. 2d, It corrupts the air, the soil, and consequently too often the wells. Instead of the common privy-vault, which is not safe even if cemented, it is best to use under the seat some receptacle which can be frequently removed and emptied. Galvanized-iron tubs, barrels sawn through the middle, &c., answer the purpose very well. If kept thoroughly disinfected with dry earth or ashes, they can be near houses, connected by passage-ways, and will not corrupt the wells.

If water-closets are used, and there are no sewers, the best disposal of the sewage is by the flush-tank, and irrigation under the surface of the soil, as described on p. 135 of the Eighth Annual Report of the State Board of Health. If cesspools must be used, they should be tight, and often emptied by the odorless process, or else have their contents pumped out on the surface of the ground for fertilizing purposes, where that can be done without causing a nuisance. If the sewage is placed on the soil in the morning of a dry, clear day, when the sun is shining, and in places where it may be readily absorbed by the earth, the odors from it are the least offensive. In very loose soil, and remote from dwellings, ordinary loose-walled cesspools may be used without danger for a short time; but even then the custom cannot be approved.

The evils arising from want of attention to the suggestions briefly given above are many; and undoubtedly much ill-health can be thus explained. Good water, from deep wells, is much better than rain-water, which is soft, and does not contain the lime, &c., so beneficial to health. If the wells and springs are kept free from contamination, as they may be with some care, until houses and streets become placed closely together, the water furnished by them is of the very best quality. A few illustrations of their baneful effects, when contaminated, are given.

A clergyman living in one of our towns reports as follows: —

"About a year ago, my son, thirteen years old, was taken sick with diphtheria. It was quite a severe case, and was very obstinate, resisting, day after day, all treatment: medicines did not have their usual effect.

By and by we thought of the water [which was found upon chemical examination to be polluted with organic matter like that found in drains and cesspools]. We immediately stopped using the water, concluding that the impure water was the probable *cause* of the boy's sickness, and the probable *reason* why the medicines would not work; for they had been mixed in this water, and he had used it for a gargle.

"With *change of water*, the sick boy at once began to mend, and was soon about the house again. This was the third case of diphtheria in our family within the space of some two years, and they were the only cases in the neighborhood; which led us to suspect something was wrong.

"I had myself been subject to a chronic irritation in my *throat*, often amounting to soreness and serious trouble, and also to frequent attacks of diarrhœa, especially through the warm weather; but, for a year past, or *since we ceased to use that water*, I have had no trouble worth speaking of in either of these ways.

"The well is in the *cellar*, almost directly under the sink, three feet only to the right of it. The top of the well is two feet and a half from the cellar-wall. The drain, originally of plank, was sixteen feet long, so that the cesspool was within seventeen or eighteen feet of the well. But this was not the worst feature of the case. This plank drain, after a time, rotted away, so that the filthy water began to soak into the ground just outside the cellar-wall, and within six or eight feet of the well, and almost directly over it. The earth, when we removed it to lay a new tile-drain, was *good manure* as deep down as we dug, and I know not how much deeper.

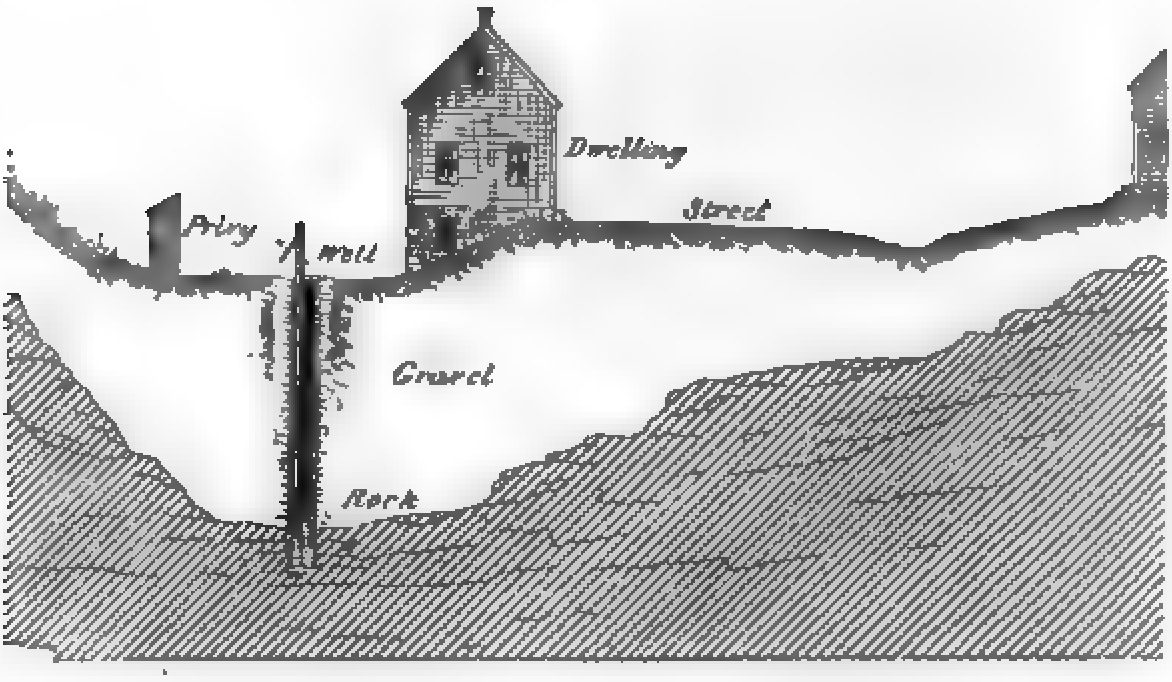
"The water looked clear, except just after heavy rains, and had *no ill smell* or *ill taste* about it. We now use cistern-water, and leave the well untouched."

This case shows what great danger to health may exist unsuspected, when the rules suggested above are not followed out. It is impossible to say that a well is safe at any ordinary distance from a source of *constant* pollution of the neighboring soil, like a privy, cesspool, barnyard, &c. Often the filth goes a long distance, sometimes not very far. *There is always a risk;* and, even if well-marked sickness does not occur as narrated above, more obscure affections are probably not uncommon.

Dr. J. G. Pinkham, in his Report on the Sanitary Condition of Lynn, published in the Eighth Annual Report of the State Board of Health, reports the following two cases, the illustrations in which are most clear and convincing: —

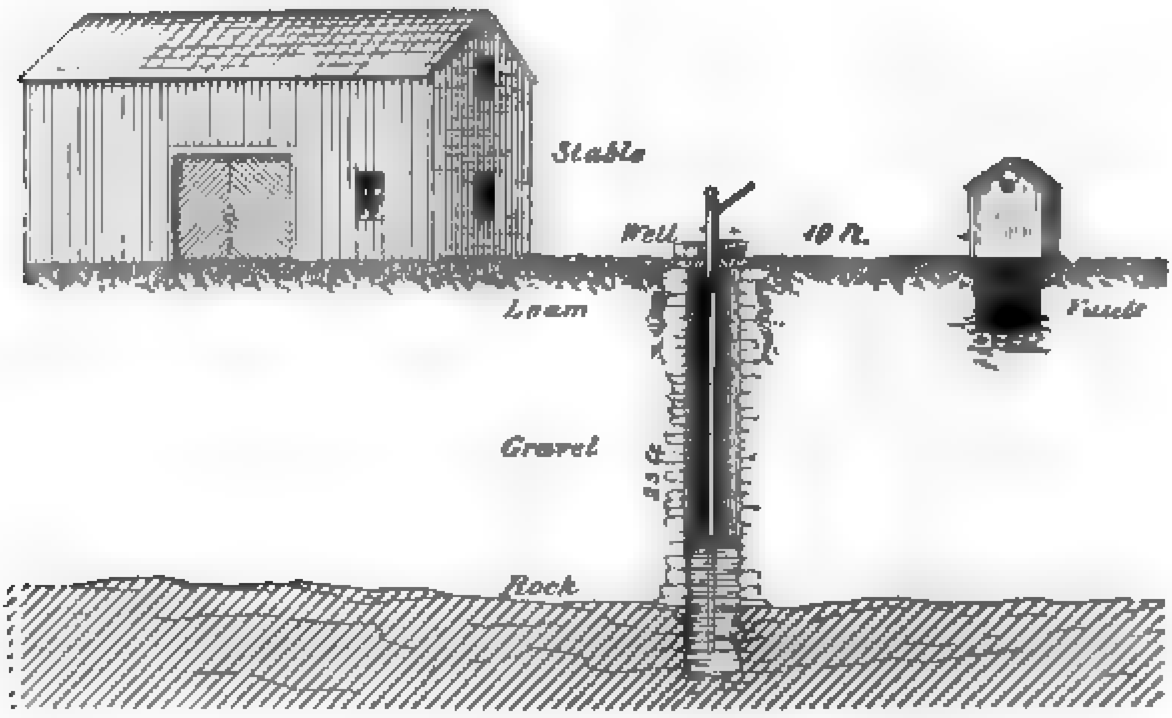
CASE NO. 1. — The diagram explains the position of the well, and shows the certainty of its pollution. The soil and subsoil are loose; contamination occurs both by surface

drainage and from soakage. Five cases of typhoid-fever occurred in 1875, in the family living in the house, and seven more, with one death, among other persons using the well-



water. This house became the centre of infection for a whole neighborhood.

CASE NO. 2.—The well is twenty-five feet in depth, a portion of it being dug into the rock. The vault is ten



feet distant on the same level. There is a cesspool in the garden below, and a stable on the left. The buildings and well are on a side-hill. The premises are kept clean, and the water, which is clear and of good taste, has been used for

many years. The occurrence of typhoid-fever in the family led the physician in attendance to suspect the water, which, upon chemical examination, proved to be very much contaminated. There were five cases of typhoid-fever in the family, and several others, with one death, among neighboring persons using the water.

Where wells are not in use, the corruption of the air from foul privies, and by the emanations from the soil of the products of decomposition of filth, becomes a prominent factor in the spread of such diseases as typhoid-fever, dysentery, diarrhœa, diphtheria, &c. In towns, sources of filth on some premises may be more injurious to the health or more offensive to neighbors than to the occupants of the place itself. Different people are differently susceptible to disease, too, so that the filthiest places are not always necessarily those where there is most sickness.

A marked illustration of disease *due to polluted air*, when the drinking-water was pure, occurred in a school in this State, in 1864, where fifty-one out of seventy-seven young ladies in the institution were attacked with typhoid-fever, of whom thirteen died; three servants also died of the fever. The vaults of the privies were shallow, filled to overflowing, and emitted a very offensive odor, which at times pervaded the whole building. The kitchen-drain discharged its contents on the surface of the ground, and a few rods from the school there was a foul barnyard.

Where filth has accumulated, and it is necessary to use a disinfectant, or if for other reasons it is desirable to do so, earth, lime, or chloride of lime will serve a good purpose. If it is wanted in liquid form, it may be made by adding to a pailful of water three pounds of copperas (sulphate of iron), with a pint of Calvert's carbolic acid; one pound of chloride of lime, or one-half pound of lime.

For use inside of houses, a solution of nitrate[1] of lead or chloride of zinc[2] (Burnett's Disinfecting Fluid) is recom-

[1] One part in one hundred of water. Cloth soaked in such a solution, and hung up in a foul air, quickly destroys bad odors.

[2] One part in two hundred of water for foul liquids, &c. This is used by order in the German navy for *bilge-water*. Labarraque's Disinfecting Fluid (chlorinated soda), one part to four of water, may be used with soap in washing floors, &c.

mended. *Whitewashing* in cellars, sheds, &c., is a most excellent means of purifying the air. *Prevention of the accumulation of filth*, however, is better than the use of disinfectants. "To chemically disinfect (in the true sense of that word) the filth of any neglected district, to follow the body and branchings of the filth with really effective chemical treatment, to thoroughly destroy or counteract it in muck-heaps and cesspools, and ashpits and sewers and drains, and where soaking into wells, and where exhaling into houses, cannot be proposed as physically possible; and the utmost which disinfection can do in this sense is apparently not likely to be more than in a certain class of cases to contribute something collateral and supplementary to efforts which mainly must be of the other sort" [*prevention* of filth].

Directions for soil-pipes, drains, &c., will be issued in a succeeding circular. At present, it need only be said that *sewers* are of the first importance where the water-carriage system is generally used for removal of sewage. Where for any reason they cannot be introduced, the greatest consideration should be used before it is decided to introduce water-closets, if the result must be to drench the soil with filth and water by means of cesspools.

It is in the highest degree important that each town should have *an independent board of health* to devote their attention to these matters. It is desirable that *at least* two-thirds of such a board should be composed of persons not otherwise connected with the town government, and that there should be at least one physician on the board.

Boards of health and selectmen of towns are particularly requested to direct the attention of proprietors of country hotels and boarding-houses to this circular, for which purpose extra copies will be sent upon application to the Secretary of the State Board of Health.

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PUBLIC DOCUMENT..... .....No. 30.

ELEVENTH REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS,

FOR THE

SIX MONTHS ENDING JUNE 30, 1879.

BOSTON:
Rand, Avery, & Co., Printers to the Commonwealth,
117 Franklin Street.
1879.

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CHARLES F. FOLSOM, M.D. . .	OF BOSTON, *Secretary.*

CONTENTS.

REPORT.

Office of the State Board of Health,
State House, Boston, June 30, 1879.

To the Honorable the Senate and the House of Representatives of Massachusetts.

The State Board of Health herewith respectfully present their eleventh Report, for the period of six months ending June 30, when the Board was abolished and the new State Board of Health, Lunacy and Charity was created.

The Law regarding Noxious and Offensive Trades.

In the case of the City of Cambridge *v.* Niles Bros., the evidence was given in detail in the Tenth Annual Report of the Board. The six points of inquiry there stated may be said, in general, to cover two questions: namely, (1) whether the establishment complained of would be a source of offence; (2) whether the water-supply of the city of Cambridge would be contaminated.

As regards the first point, it may be said, that, under the inspection of the Board, the drainage discharging into Alewife Brook, already contaminated by sewage, at first was offensive, but that the mixture of carbolic acid with it has to a considerable extent obviated that difficulty; that the soup can be mixed with the muck so as to avoid foul odors; that the machinery for manipulating the animals, the lard, the offal, etc., has been so carefully arranged, that no complaints of stenches have been heard of up to this date; that the hog-pens have been disinfected with dry loam, and that reasonable cleanliness has been observed.

With reference to the contamination of the soil, and thereby the water flowing into Fresh Pond, the rigid care exercised in making the basement and cellar floors of the buildings tight has assured the ground in the immediate vicinity from danger of being rendered impure. The drain-pipe is tight, and well cared for; and the soup may be so disposed of as to secure the

ground-water from any pollution, as may be seen from the results given below of experiments made for Messrs. Niles Bros. by Professor Nichols, as required by the Board.

Report on the Absorbing of the Soup from the Belmont Slaughter-House by Means of Muck.

At your request I have made a number of experiments with reference to the feasibility of disposing of the "soup" from the Belmont slaughter-house by absorbing it in "muck." It is not necessary in this Report to enter into the details of all the various experiments carried on in the laboratory and at the works: the details of some of them are given as an appendix.

The muck examined March 1, as it lay on the ground, contained eighty-two per cent of its weight of water, and readily loses seventy per cent on exposure to rather dry air at ordinary temperature. For the best absorptive effect, however, the muck should not be too dry. When moderately dry, as it would be in summer after several days without rain, the muck will readily absorb from one-fourth to one-third its bulk of soup. The best way, if labor were of no consideration, would be to mix the soup with as little muck as is necessary to hold it, to cover with a thin layer of muck, and to leave exposed to the air for at least ten or fourteen days ; then to mix the muck with an additional quantity of soup, and so on. In this way a large amount of soup may be incorporated, and the muck becomes more valuable as a manure. As it becomes rich, it is not absolutely odorless, and worms and maggots appear in it as in any decomposing animal matter: but, if *fresh* soup only be used, the mixing can be carried on without offence; and a very thin layer of unmixed muck thrown over the mixture retains almost all the odor. There is no advantage in mixing *fresh soup* with carbolic acid, and it would be a disadvantage if the muck were afterwards to be used for manure. Practically, on account of the labor involved, it would no doubt be found more advantageous to use a larger quantity of muck, to take less pains with the mixing, and to allow a longer interval between successive doses.

In order to ascertain how much soup is at present pumped on to the hill, I requested the keeping of an accurate record for some time. This was done from May 19 to June 7 (nineteen days in all), — seventeen working days. The total amount pumped during that time was, —

	CUBIC FEET.
Soup	1,900
Liquor from scalding-tub	1,000
Making in all	2,900

i.e., 154 cubic feet per day on the average, or 170 cubic feet for each working day. Allowing, for safety, four times its bulk of muck, this amount of 170 cubic feet would require for its absorption 680 cubic feet, or a pile three feet high and fifteen feet square, or two feet high and eighteen feet square.

In summer, if proper pains be taken, I think the soup may be safely mixed in the piles as they lie. It should be distributed over such an area, that, when it has soaked in and down, there should remain twelve or eighteen inches of muck beneath. This layer of muck will be the most efficient safeguard for the soil beneath. It is true, that, if the saturated muck be treated with a large amount of water, it is possible to leach out from it a quantity of organic matter, ammoniacal salts, etc., forming a liquid which would be valuable for a manure, but which should not be allowed to soak into the ground-water. With material like sample No. 15, a fall of rain of two inches would be absorbed by about eight or ten inches of muck, so that no liquid would drain from it. Of course, in time of continued rain, the soup should be distributed over a somewhat larger area than in dry weather.

In winter, there will be greater difficulty in securing the uniform distribution of the soup, and in preventing its passage into the gravel beneath. Supposing that, as the piles lie now, it were possible to rely in winter upon two feet of available depth of muck, to dispose of the entire discharge for five months (150 cubic feet daily for 150 days, i.e., 22,500 cubic feet), it would be necessary to allow 45,000 square feet; i.e., an acre of surface. This is supposing only one application of the soup. Probably three applications might safely be made during the five months: this would require 15,000 square feet.

If the mixing were made on a cement or other impervious floor, and under cover, so that there would be protection from severe frost, I should think that the entire discharge of five months (22,500 cubic feet) could, without doubt, be absorbed by 19,200 cubic feet (i.e., 150 cords), and possibly by 100 cords, or less. In winter there would be less danger of offence from the mixing, and on an impervious floor less care would be required to avoid over-saturation. It should be noted, that, other things being equal, the thinner the layer or pile of muck, the more soup in proportion will it absorb, because the weight of a thicker pile tends to squeeze out the liquid from the lower portions. It should also be said, that, the smaller the quantity of muck taken to absorb a given quantity of soup, the more handling would be required. Further: it is to be noted, that, as the muck becomes charged with soup, its capacity for absorbing, even at the same degree of dryness, becomes less, on account, no doubt, of the character of the solid matter left, when the water of the soup evaporates away. This solid matter chokes the pores of the muck.

In conclusion, I would say that I believe it is possible to absorb the soup in the muck without danger and without offence, and that this can be done in summer without special difficulty. I am also of the opinion that the process can be carried out in the winter, although with more difficulty. I should not be willing to recommend this method of disposing of the soup during the winter in the manner in which the soup is now applied. I think, however, that the process could be carried on safely, provided (1) that the distribution of the soup was not left to a common laborer, but was in charge of some person, intelligent and thoroughly conscientious ; (2) that the soup should be distributed in such a way, and over such an area, that the muck should not be charged at any one time

with more than one-fourth its bulk of soup. This should be ascertained by actual calculation; and if the muck should be frozen, so as not to leave two feet in depth available as calculated above, the soup should be distributed over a larger area.[1] To do this in a satisfactory manner would require the expenditure of more labor than is at present employed.

I append some analytical notes, and accompany the report with samples of muck, and description of the same.

Yours respectfully,

WM. RIPLEY NICHOLS.

MUCK. SAMPLE NO. 7.

This is a sample of muck taken from the heap on the hill, and received by me March 1. It is said *not* to have had any soup in contact with it.

It contains, —

	PER CENT.
Water	82.2
"Organic and volatile" matter (including nitrogen 0.5 per cent)	16.5
Mineral matter	1.3
	100.0

In its present condition, it will absorb *three-tenths of its bulk* of water or other liquid.

MUCK. SAMPLE NO. 14.

This is a sample of muck that has received a quantity of soup as follows: —

	CUBIC FEET.
Quantity of muck taken, 11 cu. feet	
Soup added April 5	3
Soup added April 19	2.5
Soup added May 17	1.6
In all	7.1

or $\frac{65}{100}$ of the bulk of the muck.

The soup first added had been treated with "dead oil;" afterward clear soup was used. The experiment might have been carried further.

In its present condition, this muck will absorb and hold 28 per cent; i.e., nearly one-third of its volume of water.

It contains 69.1 per cent by weight of water.

MUCK. SAMPLE NO. 15.

This is a sample of a lot treated as follows: —

	CUBIC FEET.
Quantity of muck taken, 12 cu. feet	
Fresh soup added April 19	4
Fresh soup added May 7	2.7
Fresh soup added May 17	2
In all	8.7

or about 75 per cent of the bulk of the muck.

[1] N.B. — If the soup is distributed by trenches, the distance of the trenches from each other must be calculated with reference to the available depth of muck.

No doubt, at intervals of ten or fourteen days, additional quantities could be added. The sample in its present condition can absorb about 25 per cent of its bulk of water.

It now contains, —

	PER CENT BY WEIGHT.
Water	76.1
"Organic and volatile" matter (including nitrogen 1 per cent)	14.7
Mineral matter	9.2
	100.0

It will be noticed that this sample contains about the same proportion of water by weight as the original muck. All the added water in the soup has evaporated.

It is true that the muck which was used for this experiment was not identical with that examined March 1 : it contained rather more mineral matter and fewer rootlets. It was of about the same degree of moisture.

Soup.

The soup, of course, varies somewhat; but a general idea of its character may be obtained from an examination of a sample received March 12. This sample contained 6 per cent of solid matter. The solid matter left on evaporating the soup contained 15.25 per cent of nitrogen.

Directions.

In the report which I made a few days since of my experiments with the muck, I expressed the opinion that the present method of disposing of the soup might be carried on safely, provided that some modifications were adopted, and that great care were taken.

It may be well for me to indicate the way in which I think the soup should be distributed.

If a simple trench be dug in the heap, and be then filled with soup, the liquid will soak away in all directions; but, if the material is uniform, it will sink rather more rapidly downwards than towards either side. If the trench is dug, as it naturally would be, parallel to the crest of the hill, the soup would be absorbed more rapidly on the lower than on the upper side. It is therefore important that the trenches used at any one time should not be too far apart, and that too much soup should not be put into any one trench, lest the soup should, in some places, soak entirely through the muck, and into the ground beneath.

The distance between the trenches should be about twice as great as the depth of the muck which it is proposed to make use of at the time. Thus, if the pile were three feet deep, I should leave the lowest foot as a safeguard, and calculate to use two feet for absorbing. In this case the distance between the centres of the trenches should be forty-eight inches.

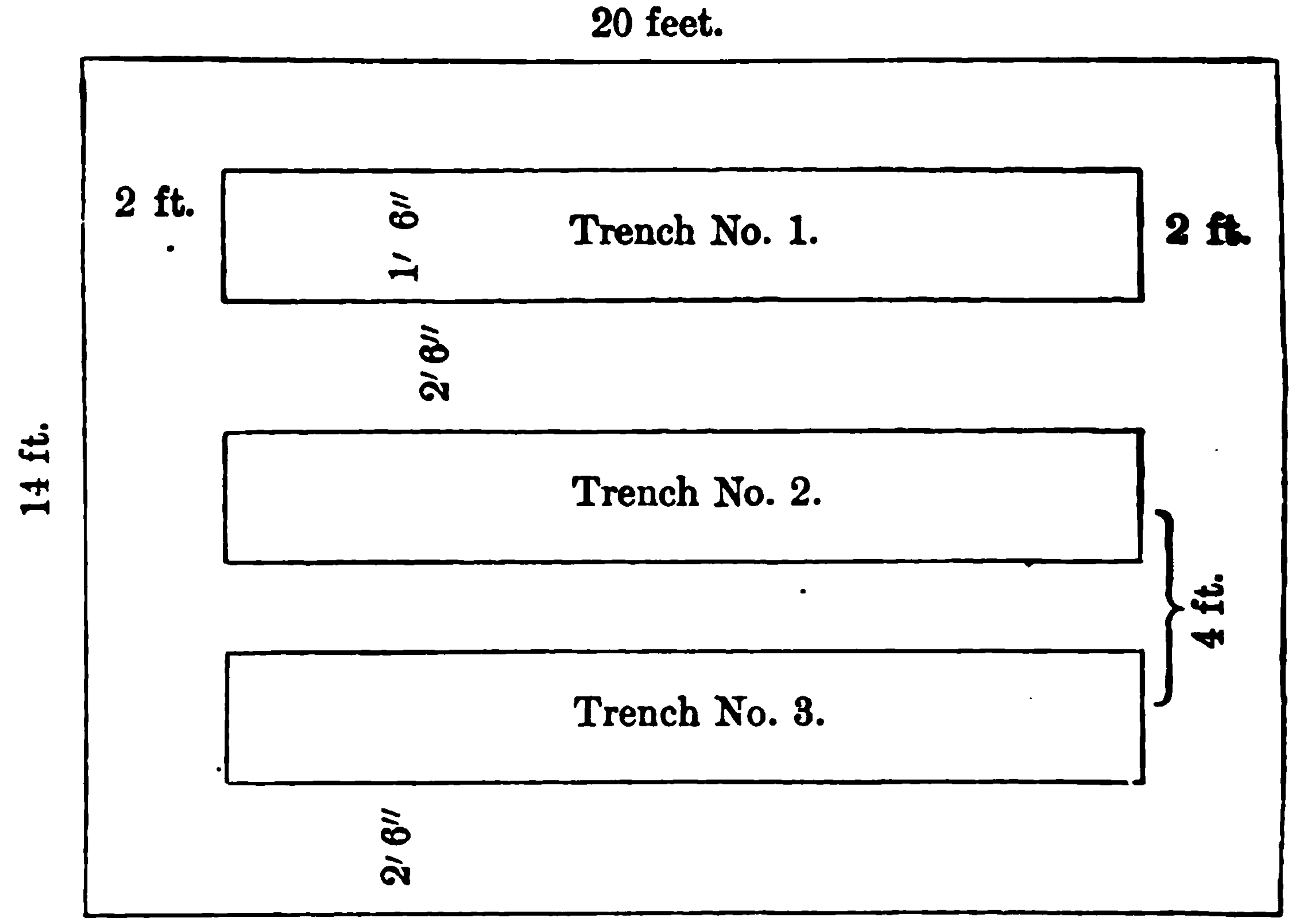
To distribute the soup I should lay out the necessary area (of which I will speak presently), and then dig parallel trenches at the proper distance apart. If the soup is brought, as now, in a pipe, these trenches need not be connected with each other; but it would be possible, if it were more convenient, to have them connected at one end with a single main trench

at right angles to the others. The soup might be allowed to flow into the connecting trench, and directed by temporary dams into the distributing trenches, — first into one, then into the next, and so on.

There should be some arrangement in the tank so that the person running the pumps can see the depth of soup at any time. This could be easily done by means of a float and index. If there are three ditches on the hill, when one-third ($\frac{1}{3}$) of the contents of the tank has been pumped, the pumps should be checked for a moment, so that the person on the hill would notice it, and turn the soup into the second ditch, and so on. As soon as the soup has soaked from the trench, the trench should be filled in with the muck at once.

As to the space necessary: Not considering for the moment the contents of the scalding-tub, which is not emptied every day, the average daily quantity of the *soup* is about 100 cubic feet. It runs up, however, so frequently to 140 cubic feet, that this latter amount should be allowed for. In order to absorb 140 cubic feet of soup, I should allow 560 cubic feet of muck. Supposing that we were using two feet in depth, it would be necessary to have an area of 280 square feet; say, a plot 20 feet by 14 feet. This area might be laid out as shown in the figure.

Of course, on the ground the measurements would not be made accurate to inches.



In this case I should run *one-sixth* ($\frac{1}{6}$) of the amount to be pumped into trench No. 1, then a like amount into No. 2, then into No. 3; and then go back, and run another sixth into No. 1 again, by which time a portion of the soup would have been absorbed. In summer, the trenches might be dug nine inches deep, and eighteen inches wide; and the calculation above is made upon that basis: but in winter they would be of necessity deeper. If they were two feet deep,

each trench would hold one-third (⅓) of the amount pumped, and it would not be necessary to go around twice. Other things being equal, the shallower the trenches the better, as the soup is more likely to be evenly distributed, and less likely to soak through the muck into the ground. When the trenches are more than nine inches deep, it will not be necessary to wait for the liquid to be entirely absorbed before the covering is begun; but, as a rule, there should be from six to nine inches of the dry material thrown over the portion which is thoroughly saturated.

It is not necessary that the trenches should be arranged as shown on the previous page; but three short trenches are to be preferred to one long one in securing even distribution.

It would not be difficult to calculate each day how large an area is required, knowing that the tank holds about 3⅓ cubic feet of soup for each inch in depth. It would be simpler to take the same space every day; and that allowed above will, no doubt, be a safe amount.

The scalding-tub holds 280 cubic feet; and, when this is emptied, it will be necessary to employ for it alone twice the space allowed above for the daily supply of soup. In very rainy or long-continued wet weather, it would be better to allow a space half as large again; but the space allowed above will be sufficient as a rule, taking rain and all into the account.

Of course, the entire area of the heaps will be treated in systematic order; and I should judge that it would be safe to return to the same spot as often as once in four or five weeks in dry weather, and six or eight weeks in wet weather or in winter.

It has been proposed to cover the muck-beds in winter with meadow-hay, or other such substance, in order to lessen the depth to which the frost can penetrate. Any method of securing at least two feet in depth of muck, which can be used as an absorbent, is desirable. This could be accomplished by having the piles made thicker; but, on account of the labor of breaking through the frozen crust, I have no doubt the plan proposed would in the end prove more economical.

Yours respectfully,

WM. RIPLEY NICHOLS.

In the case of complainants *v.* the Bradley Fertilizer Company, the Board have made careful inquiry, and consulted the counsel employed in the case, without being able to ascertain that any of the parties complaining had been troubled since the time of the hearing. Another complaint, however, was sent to the Board from four residents of Hingham, bearing date May 20, 1879, alleging that the place was a public nuisance, which ought to be abated. Since that time, a careful examination of the apparatus employed has convinced the Board that further improvements are practicable in the way of ventilation, and removal of foul gases. Professor Sharples, too,

is making experiments with reference to the possibility of more efficient destruction of the foul odors. Mr. H. P. Judson, in charge of the rendering department of the Brighton Abattoir, has visited the place with the Secretary of the Board; and the parties complained of seem very desirous of at once introducing every possible improvement, as agreed upon by these gentlemen. The petitioners do not at present desire a formal hearing.

During the eight years since the passage of the Act of 1871, the Board have had referred to them fifty-seven petitions under the law regarding noxious and offensive trades. In eight of these, no hearing was asked for, inasmuch as the action of the Board in the test case[1] was unsatisfactory to the petitioners, although it resulted in the removal of the nuisance, without destroying the business of the respondents. Six establishments have been satisfactorily regulated. In two, the parties complained of agreed to adopt the recommendations of the Board without a formal hearing. Thirty-three parties were ordered to cease and desist; and those decisions induced a number of others to give up their offensive methods of slaughtering, many of whom joined the Brighton Abattoir. In seven cases, no hearings were held, on account of some informality, because the questions involved did not come within the jurisdiction of the Board, or because no complainants appeared at the hearing. The petitioners in one case were allowed to withdraw.[2] These results express, however, far from the whole work of the Board under the law. Many complaints have been adjusted through improvements suggested by the Board; and in that way noxious and offensive trades have been so improved, that the complainants have been satisfied without a formal hearing. At the present time, although two large establishments are under the supervision of the Board, until they can be satisfied what is the proper judgment in each case, the more common result of petitions to abate nuisances is, that local boards act upon

[1] Against Messrs. J. P. Squire & Co. The petitioners, so far as the Board can learn, are now satisfied.

[2] In one case, the decision of the Board was set aside; but the jury ordered the party to adopt regulations essentially the same as those which were required by the Board (and not carried out) before the judgment to cease and desist was passed.

the advice of the State Board, or that the offensive features of the business alleged to be a nuisance are so far removed as to put an end to complaint.

Prevalent Diseases and Causes of Disease.

In continuation of the early practice of the Board, a weekly bulletin of prevalent diseases has been published, but only so far as this State was concerned, until the present year; when a memorandum was adopted, of which a copy is given below, for publication in "The Boston Medical and Surgical Journal," in order that physicians in the State might have fuller information of the approach of diseases dangerous to the public health: —

Reported Mortality for the Week ending June 7, 1879.

CITIES.	Population estimated for July, 1879.	Reported Deaths in each.	Annual Death-Rate per 1,000 during the Week.	Percentage of Total Deaths from				
				The Principal "Zymotic" Diseases.	Pneumonia.	Diarrhœal Diseases.	Diphtheria and Croup.	Scarlet Fever.
New York . . .	1,085,000	490	23.55	18.37	7.55	3.47	3.06	6.33
Philadelphia . .	-	274	-	11.31	3.65	4.74	2.19	3.21
Brooklyn . . .	564,400	171	15.79	21.06	7.02	5.26	5.85	4.68
Chicago . . .	-	108	-	14.81	9.26	-	7.41	2.78
St. Louis . . .	-	132	-	18.18	2.27	12.12	.76	.76
Baltimore . . .	365,000	125	17.85	19.20	2.80	8.00	4.80	1.60
Boston . . .	360,000	133	19.26	12.78	6.77	5.26	3.76	.75
New Orleans . .	-	88	-	12.50	3.41	10.23	2.27	-
Cincinnati . .	-	84	-	26.19	5.95	2.38	3.57	14.28
District of Columbia,	160,000	85	27.69	27.06	3.53	18.82	2.35	3.53
Cleveland . . .	-	41	-	9.76	14.63	2.44	-	4.88
Pittsburg . . .	-	39	-	17.44	10.26	2.56	5.13	5.13
Buffalo . . .	-	30	-	63.33	3.33	6.67	23.33	13.33
Milwaukee . .	-	37	-	18.90	10.81	-	16.21	-
Providence . .	101,000	24	12.39	25.00	-	4.17	16.67	-
New Haven . .	60,000	16	13.90	12.50	-	-	12.50	-
Charleston . .	57,000	39	35.66	10.26	2.56	5.12	-	-
Nashville . . .	27,000	12	23.17	16.67	-	16.67	-	-
Lowell . . .	53,300	14	13.69	14.29	-	7.15	7.15	-
Worcester . .	52,500	13	12.91	15.38	7.69	-	-	-
Cambridge . .	51,400	21	21.29	14.29	4.76	4.76	-	4.76
Fall River . .	48,500	10	10.75	20.00	10.00	-	-	20.00
Lawrence . . .	38,200	13	17.75	23.07	7.69	-	-	7.69
Lynn	34,000	13	19.94	15.38	-	-	7.69	-
Springfield . .	31,500	9	14.90	44.44	-	-	22.22	22.22
New Bedford . .	27,000	10	19.31	-	-	-	-	-
Salem . . .	26,400	10	19.75	10.00	-	-	10.00	-
Somerville . .	23,350	5	11.17	20.00	20.00	-	-	-
Chelsea . . .	20,800	2	5.01	100.00	-	-	50.00	-
Taunton . . .	20,200	5	12.91	-	20.00	-	-	-
Holyoke . . .	18,200	8	22.92	12.50	-	-	-	12.50
Gloucester . .	17,100	4	12.20	-	25.00	-	-	-
Newton . . .	17,100	5	15.25	-	20.00	-	-	.
Haverhill . . .	15,300	10	34.08	50.00	10.00	-	50.00	-
Newburyport . .	13,500	4	15.45	-	-	-	-	-
Fitchburg . . .	12,500	1	4.17	-	100.00	-	-	.

Two thousand and eighty-five deaths were reported: 382 from the principal "zymotic" diseases, 347 from consumption, 121 from pneumonia, 110 from diarrhœal diseases, 90 from diphtheria and croup, 83 from scarlet fever, 42 from bronchitis, 28 from typhoid fever, 24 from whooping-cough, 13 from cerebro-spinal meningitis, 11 from malarial fevers, 10 from measles, six from erysipelas, five from remittent fever, four from pleurisy, one from intermittent fever, and one from typho-malarial fever, none from small-pox (five *cases* are reported from Richford, a small town in the extreme north of Vermont). In the mortality from measles, cerebro-spinal meningitis, diphtheria and croup, whooping-cough, typhoid fever, pneumonia, and bronchitis, there is no noteworthy change. The decrease in scarlet fever and erysipelas continues. There is a slight increase in consumption, moderate from "zymotic" diseases and all causes; while the fatality from diarrhœal diseases is nearly double that of the previous week. In the nineteen cities of Massachusetts, with an estimated population of 880,850, there is shown a gradual increase in diarrhœal diseases, a decrease in scarlet fever, and no other noteworthy change.

From *bronchitis*, 18 deaths were reported in New York, six in Brooklyn, four in Philadelphia and Boston, two in Milwaukee, one in Chicago, St. Louis, Baltimore, District of Columbia, Buffalo, Providence, Cambridge, and Salem. From *typhoid fever*, 10 in Philadelphia, four in New York and Chicago, three in Cincinnati, two in Boston and Lawrence, one in Baltimore, Buffalo, and Cambridge. From *whooping-cough*, eight in New York, two in Philadelphia, Brooklyn, and Charleston, one in Chicago, St. Louis, Baltimore, Boston, Cincinnati, District of Columbia, Pittsburgh, Buffalo, Providence, and Chelsea. From *cerebro-spinal meningitis*, two in Baltimore, Buffalo, and Worcester, one in New York, Philadelphia, Cincinnati, Cleveland, Milwaukee, Lynn, and Somerville. From *malarial fevers*, seven in New York, five in Brooklyn, four in St. Louis, one in Baltimore and District of Columbia. From *measles*, six in New York, two in Cleveland, one in Brooklyn and Baltimore. From *erysipelas*, two in Buffalo, one in New York, Brooklyn, St. Louis, and Boston. The death-rate of the colored population in the District of Columbia was more than double that of the whites.

The weather was generally reported cooler and changeable, with light rains; the meteorological record for the week in Boston (latitude 42° 41′, longitude 71° 4′) being as follows: —

DATE.	Barometer.	Thermometer			Relative Humidity.				Direction of Wind.			Velocity of Wind.			State of Weath'r.[1]			Rainfall.	
	Mean.	Mean.	Maximum.	Minimum.	7 A.M.	2 P.M.	9 P.M.	Mean.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	Duration.	Amount in Inches.
June 1.	29.913	83	96	67	77	85	59	57	SW	SW	SW	10	16	12	C	F	C	—	—
" 2.	29.910	70	91	55	72	55	88	72	W	W	NE	6	12	14	F	O	R	—	.03
" 3.	30.075	50	55	49	100	100	100	100	E	NE	NE	15	14	9	R	R	R	—	.60
" 4.	29.895	60	66	50	100	97	91	96	O	S	SW	[illegible]	7	4	R	R	F	—	.88
" 5.	29.833	68	78	56	77	53	77	69	SW	SW	SW	6	12	1	F	O	F	—	.48
" 6.	29.764	63	77	53	72	74	55	67	O	O	W	0	0	20	O	F	F	—	.35
" 7.	30.014	54	62	45	63	23	56	49	NW	NW	W	16	17	4	C	F	F	—	.05
Week.	29.916	64	96	45				73		SW		1,629 miles						45	2.2

[1] O, cloudy; C, clear; F, fair; G, fog; H, hazy; S, smoky; R, rain; T, threatening.

For the week ending May 17, in 144 German cities and towns, with an estimated population of 7,315,369, the death-rate was 28.4, an increase of 0.1 over the previous week, indicating a decrease in consumption, diphtheria and croup, and typhus fever, an increase in scarlet fever, measles, and typhoid fever, while the other prominent diseases remained about the same. Three thousand nine hundred and ninety-three deaths were reported: 590 from consumption, 507 from acute diseases of the respiratory organs, 211 from diarrhœal diseases, 102 from diphtheria and croup, 62 from typhoid fever, 61 from scarlet fever, 56 from whooping-cough, 45 from measles, 21 from puerperal fever, seven from typhus fever, two from small-pox (Berlin and Augsburg). The death-rates ranged from 14.7 in Mannheim to 45.4 in Augsburg; Konigsberg, 32.2; Dantzic, 21.2; Breslau, 30.6; Munich, 40.5; Dresden, 27.8; Cassel, 20.2; Berlin, 24.4; Leipsic, 24.6; Hamburg, 31.3; Hanover, 27.8; Bremen, 30.4; Cologne, 24.6; Frankfort-on-the-Main, 23.9; Darmstadt, 19.7. Also for the same week: Vienna, 33.6; Prague, 44.4; Paris, 27.7; Odessa, 30.7.

For the week ending May 24, in the twenty English cities and towns having an estimated population of 7,383,909, the death-rate was 21.4, — a decrease of 1 from the previous week, — with a decline in the mortality from respiratory diseases, diphtheria, scarlet fever, and fever; a very slight increase in measles and whooping-cough, considerable in diarrhœa, and nearly trebled in small-pox (London). Three thousand and twenty-nine deaths were reported: 327 from diseases of the respiratory organs, 109 from whooping-cough, 79 from scarlet fever, 75 from measles, 38 from fever, 35 from diarrhœa, 17 from small-pox, 12 from diphtheria. The death-rates ranged from 16.3 in Brighton to 25.1 in Norwich, 21.6 in London, 17.4 in Bristol, 23.1 in Birmingham, 23.8 in Liverpool, 24.1 in Manchester, 18.6 in Leeds. In Edinburgh the rate was 24; in Glasgow, 21; in Dublin, 35 (small-pox declining).

The sanitary condition of Astrachan and vicinity is reported to be good: typhus fever has become less prevalent. There is a slight increase

in small-pox in the large cities of Europe where it prevails, and a decrease in Poland.

The circulars with reference to prevalence of diseases in the State were sent this year for a quarterly period, instead of annually as heretofore, and to the boards of health, with the request that they would consult, in making their replies, the physicians employed by them, or the medical correspondents of the Board. Two hundred and twenty-three replies were received, or from about two-thirds of the cities and towns in the State. In this way a great deal of valuable information was received, although not of a kind which can be tabulated to advantage, or reported upon a standard constant enough to admit of comparisons between towns or even counties. It may be said in a general way, that pneumonia, rheumatism, neuralgia, and especially influenza, were unusually prevalent throughout the State. It seems desirable, in the future, to even further simplify the system of tabulation and reporting of diseases. The circular sent out for the first quarter of the year was as follows: —

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, March 25, 1879.

To the Chairman of the Board of Health.

DEAR SIR, — In order to receive important information with regard to the prevalence of disease throughout the Commonwealth, the State Board of Health have prepared the enclosed table, which they hope you will be kind enough to fill out and return at your earliest convenience.

If there is no physician on your board, will you please consult, in preparing your replies, the physician employed by you, and *especially the medical correspondent* of the State Board of Health, Dr. ——— ?

Please put a cross in the proper column, and opposite the name of each disease, to indicate whether it was absent, slightly prevalent, prevalent, or very prevalent; adding another cross if the particular disease was *also fatal*, and a zero if *not fatal:* for example, —

DISEASE.	No cases known.	Slightly prevalent.	Prevalent.	Very prevalent.	REMARKS.
Measles . .			×○		In March.
Scarlet Fever .			××		For part of January.
Rheumatism .		×			Never common here.
Small-Pox . .	×				One case of Varioloid in February.
Intermittent Fever,					A few cases *not originating here.*

Under the table may be put remarks with regard to these diseases or *others not on the list*, suggestions as to *causes of disease*, subjects which you desire the State Board of Health to investigate, etc.

In behalf of the State Board of Health,

Very respectfully yours,

CHAS. F. FOLSOM, M.D., *Secretary.*

Prevalent Diseases, First Quarter, 1879.

Reply from the Board of Health of the city or town of ________________

Physicians consulted, ____________________________________

DISEASE.	No cases known.	Slightly prevalent.	Prevalent.	Very prevalent.	REMARKS.
Small-Pox . .					
Measles . .					
Scarlet Fever .					
Cerebro-Spinal Meningitis .					
Diphtheria and Croup . .					
Whooping-Cough .					
Erysipelas . .					
Typhoid Fever .					
Diarrhœal Diseases,					
Rheumatism . .					
Neuralgia . .					
Influenza . .					
Intermittent Fever,					
Acute Lung-Diseases . . .					
Chronic Lung-Diseases [1] . .					

[1] Under this head, please note their *prevalence as causes of death.*

In the second quarter the following form seemed more desirable: —

DISEASE.	No case known.	Prevalent.	REMARKS.
Measles		×o	
Scarlet Fever		××	
Rheumatism			
Small-Pox	×		
Intermittent Fever . .			

Prevalent Diseases, Second Quarter, 1879.

Reply from the Board of Health of the city or town of____________

Physicians consulted, ________________________

DISEASE.	No case known.	Prevalent.	REMARKS.
Small-Pox			
Measles			
Scarlet Fever . . .			
Cerebro-Spinal Meningitis .			
Diphtheria and Croup . .			
Whooping-Cough . .			
Erysipelas			
Typhoid Fever . . .			
Diarrhœal Diseases . .			
Rheumatism . . .			
Neuralgia			
Influenza			
Intermittent Fever . .			
Acute Lung-Diseases . .			

It is especially in this connection that the assistance of the medical correspondents of the Board has been of very great value. Before local boards of health were established, even in our largest cities, they acted as reporters in matters relating to the public health. Their services were given cheerfully, and without pay. They have contributed largely to whatever success has attended the work of the Board, and deserve the gratitude of all those who have been interested in the development of the science of preventing disease. Their replies to the circulars of the Board from year to year embrace discussions with regard to a large range of subjects relative to sanitary laws, and a collection of facts, preserved for future use in thirty large volumes, which are of special value.

The distribution of circulars on matters relating to the prevention of disease has continued. Since the publication of the last Report, three more, as follows, have been added to the list. It is a cause of congratulation to the Board that these circulars have been somewhat widely reprinted outside of our own State.

DISINFECTION.

A CIRCULAR FROM THE STATE BOARD OF HEALTH.

Recent experiments made under the direction of the International Cholera Commission have shown that the ordinary methods of disinfection are inefficient, and, in practice, they have often failed to arrest the spread of infectious diseases.

As it is impossible to experiment directly upon the *unknown* low organisms, which are thought to be the means of transporting the various infectious diseases, the effects of chlorine and sulphurous acid were studied upon *known* living organisms; the probabilities being thought to be in favor of the theory that complete disinfection should destroy at least all known forms of life, although it may be true that the tenacity of life of the infective matter of various diseases differs, just as the degree of cold necessary to put a stop to yellow fever is much less than that required to arrest the spread of cholera.

Chlorine and sulphur fumes, in sufficient quantity, were found to be efficient in killing insects, fungi, bacteria, and infusoria; the objections to chlorine in houses being that it is more costly, that its use is more difficult, and that it destroys metals, textile fabrics, and colors.

The burning of ten grams of sulphur for each cubic meter of air-space, tightly closed, was found *not* to kill bacteria, infusoria, or all insects. Twenty grams, however, were proved to be sufficient for that purpose. One volume of water, when saturated at 59° F., absorbs thirty-seven volumes of sulphurous acid, — enough to kill all the low organisms found in putrid urine.

The following articles were found uninjured after several hours' exposure to an atmosphere in which twenty grams of sulphur had been burned to every cubic meter of air-space: A clock of steel and brass; rusty and clean nails; gold and silver money; a military epaulet; various colored silk articles; a colored rug; calico; down-pillows; a gilt-framed looking-glass; books; water in an uncorked bottle; flour; meat; salt; bread; apples; cinnamon; vanilla; cigars; wall-paper; oil-paintings; varnished articles; gas-fixtures; water-fixtures. A highly polished razor had a slightly cloudy appearance on its upper side, but that was easily rubbed off. The flour and meat were cooked and eaten, and the cigars were smoked, without any abnormal taste or smell being observed; in the bread not all of the observers noticed a slightly acid taste; the inside portion of the apples was unchanged, the skin was slightly sour; the water, after standing, had an acid reaction, but no decided taste or smell. Litmus-paper placed between the leaves of books and under the carpet was turned bright red. Many of the articles exposed had a decided smell of sulphur at first, but that soon disappeared.

The experiments seemed to show that clothing, bedding, and other articles may be disinfected without being changed chemically or injured; and it should be added, that practically this method has apparently accomplished perfect disinfection, as tested in Berlin.

If we may judge from these results, effective disinfection, by burning

sulphur, requires eighteen ounces to each space of one thousand cubic feet. The sulphur should be broken in small pieces, burned over a vessel of water or sand, so as to avoid danger from fire; and, if the room is large, it should be put in separate vessels in different places. The room should be tightly closed for six hours, and then aired: it is better that the room should be warm than cold. Of course, efficiently disinfected air is, during the process of disinfection, irrespirable. Most articles may be disinfected in this way, if hung up loosely in the fumigated chamber, although it would be an additional safeguard to expose any thing thick, like a bed-mattress, to prolonged heat at a temperature of about 240° F.; and, indeed, heat must, with our present knowledge, be considered the best disinfectant. With this end in view, local boards of health are advised to procure furnaces and laundries, as is commonly done in other countries, to be used for the sole purpose of disinfecting articles which have been exposed to the infectious diseases, as recommended in the Ninth Annual Report of the State Board of Health, and described by Dr. A. H. Johnson, in an exhaustive paper on Scarlet Fever (pp. 255 *et seq.*), in that report. Of course, a much simpler disinfecting furnace than that described will answer every purpose. For ordinary use, in disinfecting *houses*, the sulphur process is the best.

A solution of chloride of zinc (one part of Burnett's disinfecting fluid to two hundred of water) very quickly kills bacteria *which have been placed in it*, and arrests putrefaction. Caustic lime serves equally as well (1 to 100), but leaves a sediment not always easy to remove. Carbolic acid in sufficient strength to be effective (1 to 100) is more expensive, and of disagreeable odor.

It is needless to add that "disinfectants" used in sufficient quantities to destroy bad smells do not necessarily kill microscopic living organisms: and it is not supposed that they directly influence the so-called "germs" of the infectious diseases, unless concentrated to the extent which has been mentioned.

Finally, fresh, pure air acts as one of the best "disinfectants" by enormously diluting the infectious matter, and, under certain conditions, including time, must render it inert to all effect, even if not quickly destroying it, as many think is the case.

State House, Boston, April, 1879.

A CIRCULAR TO LOCAL BOARDS OF HEALTH.

THE CARE OF YOUNG CHILDREN.

The diseases of children which cause the greatest mortality occur mainly during the hot months, or immediately thereafter, and are due largely to overcrowding of population, in cities and in thickly populated parts of towns. They are much aggravated, if not directly caused, by filth of all kinds, especially by filth putrefying under the influence of summer heat.

Therefore infants and children should be taken, so far as it is possible,

during the summer, to places where the air is clean and cool: if not to live in the country or at the seashore, then to parks, open squares, beaches, etc., for a day, or for as many hours at a time, and as often as may be. All sources of impure air in and about the dwelling should be avoided; the drainage should be carefully looked after; the water-supply should be pure; no sink-spouts should pour filthy water on the soil; there should be no untrapped sinks or drains, no stinking privy or pig-sty, no ill-arranged water-closet,[1] no arsenical wall-papers, etc., to poison the air. Soiled clothing, diapers, etc., should be promptly removed from the rooms.

A baby should not sleep in the same bed with another person, and should have plenty of fresh air day and night.

Food.

Improper food is directly or indirectly connected with at least one-half of the deaths of young children. Of all the deaths under one year in Massachusetts, more than one-quarter are from diseases of the digestive apparatus, mainly of diarrhœal character. Errors in diet cause also a vast number of deaths which do not show their real nature in the mortuary records; — for instance, very many cases of "teething," "convulsions," "marasmus," "atrophy," "wasting," "hydrocephalus," etc., come under that head; and, furthermore, many cases of disease of the lungs, otherwise trivial, become dangerous because occurring in children previously weakened by indigestion.

The new-born child should, if possible, live altogether on the milk of its mother, or, failing that, of a *perfectly healthy* wet-nurse, unless, indeed, when the mother has not quite enough milk, the physician thinks best to supplement it with bottle-food. If neither the milk of the mother nor of a wet-nurse can be had, the milk of the cow or some other animal may be used instead; and this should be supplied fresh night and morning, — not necessarily from one cow.

Milk warm from the cow can usually be taken undiluted by infants of any age; if it has time to cool, it should be thoroughly chilled immediately after milking, before being used for feeding infants.

Whether the baby be nursed or bottle-fed, the meals should be given at regular intervals during the day, every two, three, or four hours, according to the age and vigor of the child; during the night, only once or twice, for one or two months; after that, once or not at all.

The infant should not be allowed to go to sleep during its meals, but should be made to nurse continuously, except for occasional rests of a few seconds, until it has taken all it wants. By this means it soon learns to take just the quantity it needs; and, being neither hungry nor over-filled, it sleeps or lies comfortably between meals.

Crying should not always be considered a sign of hunger, and nursing out of meal-times should never be used to quiet the child.

Both breasts should be used at each nursing; and, when the milk has any tendency to be scanty, each breast should be given twice at each meal.

[1] See circulars on House-Drainage, and on Soil-Pipes and Drains.

It is not always easy to tell whether a child gets as much milk as it ought. Not infrequently when the mother or nurse is losing her milk, and the child is obviously failing, it will yet seem to be satisfied at each meal, probably because it has learned not to expect more, and has ceased to hope for it. Then it suffers for want of sufficient food, and should, of course, be fed from other sources. Drawing on an empty breast, too, is in itself injurious to the child.

It may be said in general, that the food which suits the mother will make good milk. It would be better to abandon most of the current *popular* theories as to what is or is not suitable for nursing-women. Perhaps the most objectionable one is that milk is indefinitely increased by taking large quantities of fluid. Certainly enough extra fluid must be taken to supply the extra amount demanded by the breast. Such vegetables and fruits as give the mother indigestion, or such as are found by experience, from some individual idiosyncrasy, to disturb the child without disturbing the mother, should be avoided; but, as a rule, the mother should eat what she usually finds conducive to her health.

It should generally be left to a physician to decide whether or not a mother is able to nurse her child. Mothers often think their child is not thriving on breast-milk, when the real difficulty arises from faulty habits of nursing, irregularity of meals, etc.

Cow's milk is usually, on the whole, the best material for supplying the place of the natural food. The constituents of cow's milk and of human milk are mainly water, casein, fat, and sugar, although not in the same *proportions*; but that is not the most important difference between the two milks, as may be seen when they are curdled. The curds of human milk are soft and flocculent; those of cow's milk tough and leathery, with a tendency to contract and become more and more hard.

Pure cow's milk is not often well digested by infants under six months old, nor always by older ones. The hard curds that it forms are often vomited, or pass through the bowels, and appear in the discharges. It therefore becomes necessary to dilute it with water or some other material. When water is used, it is commonly found best to give from one-third to one-half milk and from two-thirds to one-half water for the first month or six weeks, and then gradually to diminish the amount of water until at the age of six or eight months the milk is given without water. If the milk has been watered before it is bought, as sometimes happens, it may be given in larger proportion. These rules for diluting milk may only serve as a general guide; for all children have not the same powers of digestion, and some milks contain much more water than others. The greatest care should be taken that the water for diluting milk be not contaminated. If there be any suspicion of its impurity, it is well to boil it, as some physicians recommend in all cases. As human milk contains a larger proportion of cream than cow's milk, it is usual to let the milk stand a while, and take the upper part of it, after the cream has begun to rise. For a similar reason, sugar often is added to the diluted milk; usually ordinary cane-sugar, but sometimes by preference sugar of milk, on the theory, that, resembling the natural sugar of the human milk, it will be less likely to cause indigestion.

If large curds are vomited or passed by the bowels, an alkali should be added to the milk (from two to five grains of bi-carbonate of soda or bi-carbonate of potassa, or from one teaspoonful to a tablespoonful of lime-water, in each bottle of food[1]).

The test of a method of feeding is the health of the child; and when, as often happens, children do not thrive well on milk simply diluted, there are several ways of preparing it that will usually make it more digestible. The principle is essentially the same in all; namely, to thicken the milk, and thus prevent the lumping of the curds. Barley, oatmeal, Graham-meal, flour, arrow-root, corn-starch, rice, gelatin, isinglass, and gum-arabic are all used in this way, and then all answer about the same purpose. They contain, it is true, some more, some less nourishment, but much less than the milk with which they are combined; so that their effect, when thus used, may be regarded as chiefly mechanical. The starchy parts of them are not absorbed by young infants, except to a very slight extent.

One of the best home-made preparations is of oatmeal. One table-spoonful of coarse oatmeal is left to soak over night in a quart of water. In the morning it is boiled down to a pint, and strained while hot. When cool, it is of the consistence of jelly, and should be mixed with milk, generally in equal parts, only when about to be used. Pearl-barley may be treated in the same way, and is preferable, if the bowels are relaxed.

There are many manufactured articles in the market, some of which are valuable and may be advantageously employed under medical advice.

Condensed milk sold in open cans is milk simply deprived of some of its water, and has the advantage over undiluted milk that it is less likely to sour in the thick state in which it is kept until ready for use. The taste of it is somewhat changed by the process of condensation, so that the flavor resembles that of boiled milk; but this does not seem to make it less easily digested or less nutritious. It should be diluted with rather less than four times its volume of water, to make it equal to ordinary milk. It cannot be kept in warm weather more than three or four days.

The milk sold in sealed cans is condensed when fresh, and seems to retain the qualities of fresh milk for a very long period, unless it is diluted; so that, in spite of containing a great amount of sugar, the best preparations of it are sometimes useful.

Artificial food, when given, should be about blood-warm.

Babies brought up by hand may take their food from a spoon, a cup, the so-called china duck, or from a nursing-bottle. The bottle has the advantage that the food is obtained by the natural process of sucking: the flow of the food is uniform, and not too rapid. The spoon, cup, etc., have the advantage that they are more easily cleaned, and are decidedly preferable, if the nurse or mother will not use great care.

The bottle should be of the simplest possible arrangement. The best

[1] To make lime-water, put a piece of unslaked lime, as large as a hen's egg, in an earthen vessel, and pour on it slowly a gallon of pure cold water. After a few hours, skim it, and pour off the clear fluid, which should be tightly corked in bottles.

consists of a nipple of soft black rubber, with holes small enough to prevent a too rapid flow, snapped over the lip of a plain bottle with a tapering neck. It should contain eight ounces for young children, and ten or twelve for older ones.

The bottle and nipple should be rinsed out in cold water, and then left entirely immersed in water until wanted for use again. If this is faithfully done, no other washing is required. But, if the milk dries upon the glass or the rubber, it sometimes cannot be removed except with carbonate of soda, scalding, and scrubbing. When thoroughness cannot be assured, it is well to use a weak solution of carbonate of soda for rinsing regularly.

Tubes and joints are objectionable, unless *extraordinary care* can be assured in keeping them clean. They should be put in a weak solution of common cooking-soda, and be rinsed thoroughly before use.

Weaning.

The infant should be weaned in one of the cool months, not between May and October: it should be about one year old, not younger than nine, nor older than fifteen months. It is very injurious for both mother and child to continue the nursing too long.

Long before the time of weaning, the infant should have become accustomed to other food, in addition to the breast-milk it should have learned to drink milk, or one of the preparations already mentioned, for one meal. At seven or eight months, this may be varied by the addition of softened bread, and by giving simple meat-soup or beef-tea. It is not particularly desirable to give to healthy children meals of concentrated soups or expressed beef-juice, the true aim being, not to crowd the child with nourishment, of which it can easily get enough, but to encourage a vigorous and natural digestion.

As the time for weaning approaches, the number of food-meals may be increased so that the child will be induced to give up the breast with very little difficulty.

Only simple food should be given, and at regular times, avoiding pies, cakes, unripe or over-ripe fruits, soothing-sirups, patent medicines, etc.

Bathing and Clothing.

The infant should be washed thoroughly all over every day once, and during very hot weather twice.

For a few weeks the water should be at about blood-heat or a little below it, from 98° Fahrenheit down to 95° Fahrenheit; and, later, it should be lowered so, that, at an age varying with the health and vigor of the child, the water should be warmed only enough to take off the chill.

It is better to put a baby into a bath of water than to bathe it in the lap; and the water should, if possible, be deep enough to cover it up to the neck.

When no bath-tub is to be had, the best thing to use is the ordinary tin wash-boiler.

The best way to avoid a chill after the bath is to wrap the child at once in a warm cotton sheet or towel, placed on a warm blanket.

The best clothing is that which is warm, and at the same time light. Flannel is the best material for all seasons of the year. Especially in the cool weather following the heat of August, infants are very susceptible to the influence of cold, and at that time they should be looked after with particular care. It is better that the bands of pinning blankets and skirts should be of flannel rather than cotton. Loose blankets and shawls that easily change their position on the body, or get forgotten occasionally, are undesirable garments. The shoulders, arms, and legs should be covered in cool weather, especially during the first four months; the stomach and bowels should always be carefully protected from cold.

Quite as much attention should be paid to keeping the child cool in summer as to keeping it warm in winter. Overheating is a common source of sickness.

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, June, 1879.

NOTE.—Copies of this circular may be had upon application to the Secretary of the State Board of Health.

NOTE.

Ridge's food, imperial granum, prepared groats, and prepared barley are manufactured articles; and the exact peculiarities of them are not known, except that they are found to suit the digestion of many babies. As a rule, they should be given in such proportion, that the food, when ready for use, will pass easily through the nursing-bottle.

Two preparations, Nestlé's and Gerber's lacteous farina, are exceptions to the above rule, and are real foods; that is, they really contain milk, but in a dried and powdered form. With the milk is supposed to be combined a powder of bread-crust, which is rich in dextrin, a soluble substance resembling starch. Unfortunately, these preparations, though very valuable forms of food, are quite expensive. It cannot be otherwise than a misfortune, also, that they are made by a secret process.

It is claimed that Horlick's (American) and Mellin's (English) food contain all the constituents of Liebig's soup for babies, except milk.[1] They appear to be identical with each other, and are valuable as additions to milk.

CIRCULAR TO LOCAL BOARDS OF HEALTH.

HOUSE-DRAINAGE.

The first principle in house-drainage is, that there ought never to be any constant bad odor connected with it. If there be such, it is an indication that *there is a defect somewhere*. Occasional offensive smells also

[1] Baron Liebig's soup for babies, made of malt, flour, bicarbonate of potash and milk, is a very valuable food. It requires, however, more than half an hour's cooking every day, and its place seems to be fairly supplied by Mellin's and Horlick's food.

usually reveal imperfect workmanship, incorrect methods, bad ventilation, or some failing in the quality of materials used or in the proper working of some of the various parts.

As the different means of allowing escape of sewer-gas into dwellings frequently exist for a long time without being detected, and as people may become so habituated to the daily presence of bad smells as not to notice them, it is evident that as much of the plumbing and of the soil-pipes as possible should be *readily accessible to frequent inspection*, to allow of the application at once of the proper remedy for each defect. Inside the house the drains should be of iron, with flange or well-tamped lead joints, and not be so laid under the cellar-floor that they cannot be seen.

The danger to a healthy, vigorous person from breathing foul air, so far as the specific diseases are concerned, is much less than is commonly supposed; yet it is a risk of so great an injury that it should, of course, be avoided. If the foul air comes from a general sewer-system, especially when the sewers are so badly constructed as many in our cities, or if from defective drains, allowing fifth to accumulate and putrefy, the danger is ordinarily much greater than from filth before decomposition has begun; and the sense of smell, too, does not so constantly furnish a warning of its presence.

For a temporary purpose, and especially to arrest decomposition and destroy bad odors, disinfectants serve a good purpose; but they are simply palliatives at best, because they *cannot be efficiently applied* directly *to all places* where filth is likely to accumulate; and they should be depended upon only when the radical measures of prompt and effective removal of all filth, with thorough ventilation, cannot be adopted. Chloride of zinc (Burnett's Disinfecting Fluid), one part to four hundred of water, and carbolic acid, one part to a hundred, kill the *known* low organisms (*fungi, bacteria, infusoria*) immersed in them, and in that proportion are probably thorough disinfectants;[1] but, of course, the concentration must be increased according to the amount of filth in the fluid to be disinfected.

Drains should be of such a size (not over six inches in diameter for an ordinary house) and shape (round) as to concentrate the flow of drainage, and prevent deposits; smooth inside, with continuous lines, free from offsets or jogs at the joints, of suitable inclination (one foot slope in twenty-four will usually be the least that is safe, unless a flush-tank is used), and properly connected with the soil-pipes at one end and the sewer at the other, strong, and of durable material (glazed earthenware or iron). They should be used for all *liquid* refuse, but never for garbage or ashes; and no filth or dirty water should be thrown out in back yards, except to be taken up at once by vegetation ; and it should never be allowed to run in gutters in the streets. The common defects in drains cannot all be mentioned here, but are fully discussed in articles by E. S. Philbrick, C.E., and E. C. Clarke, C.E., in the seventh and tenth Reports[2] of the Board.

[1] Three pounds of green copperas and one pint of carbolic acid to a pail of water may be used as a cheap and useful palliative of filth which cannot be promptly removed.

[2] These Reports may be found in most of the libraries in the State, or upon application to the board of selectmen.

As a defective house-drain may affect not only the occupants of the house, who may not be owners (and many of whom may not be even tenants), but even a whole neighborhood, every house-drain at least—and better, also, soil-pipes and plumbing—should be constructed and arranged according to approved plans, and be under municipal inspection and control. A plan of the work should always be put on record, both for future use, and because its preparation will insure some forethought and care in its adaptation to the requirements of house and sewer,—and particularly as neither owner nor mechanic can commonly prepare such plans with accuracy and nicety, without calling for advice on some one skilled in that work. It would be well to have two copies of ground-plan and profile,—one to be kept at the house, and the other with the officers in control of the sewer department. The plans should contain *all the works projected*, in connection with the supply of air[1] and water to the house, together with the apparatus for removing the water, after its use, from sinks, water-closets, bath-rooms, etc., through soil-pipes, drains, traps, etc.; and this plan should include *grades* also of all important parts (cellar, drains, catch-basins, yards, sewer).

Drainage of wet sites for houses is also of very great importance, as well as drainage to remove filth; when needed, the same principles are involved, and the same processes applied in its application, as in agricultural drainage. Tile-drains, from two to five inches in diameter, with a fall of not less than one foot in one hundred, are the best for that purpose: they should be laid at least six inches—but better two feet—below the level of the bottom of the cellar. They should never be used to carry away kitchen-slops, or indeed any thing except the water from the soil and subsoil. They should be placed about twenty feet apart in tough soil or clay, and from that distance to forty feet apart in gravel, etc. *Damp cellars are injurious to health:* they often produce consumption, pneumonia, rheumatism, neuralgia, and predispose to diphtheria and other diseases, although strong, vigorous persons frequently do not feel their immediate influence upon themselves, and it is not always felt upon their children. [See a paper by Hon. H. F. French, in the Fourth Annual Report of the Board.]

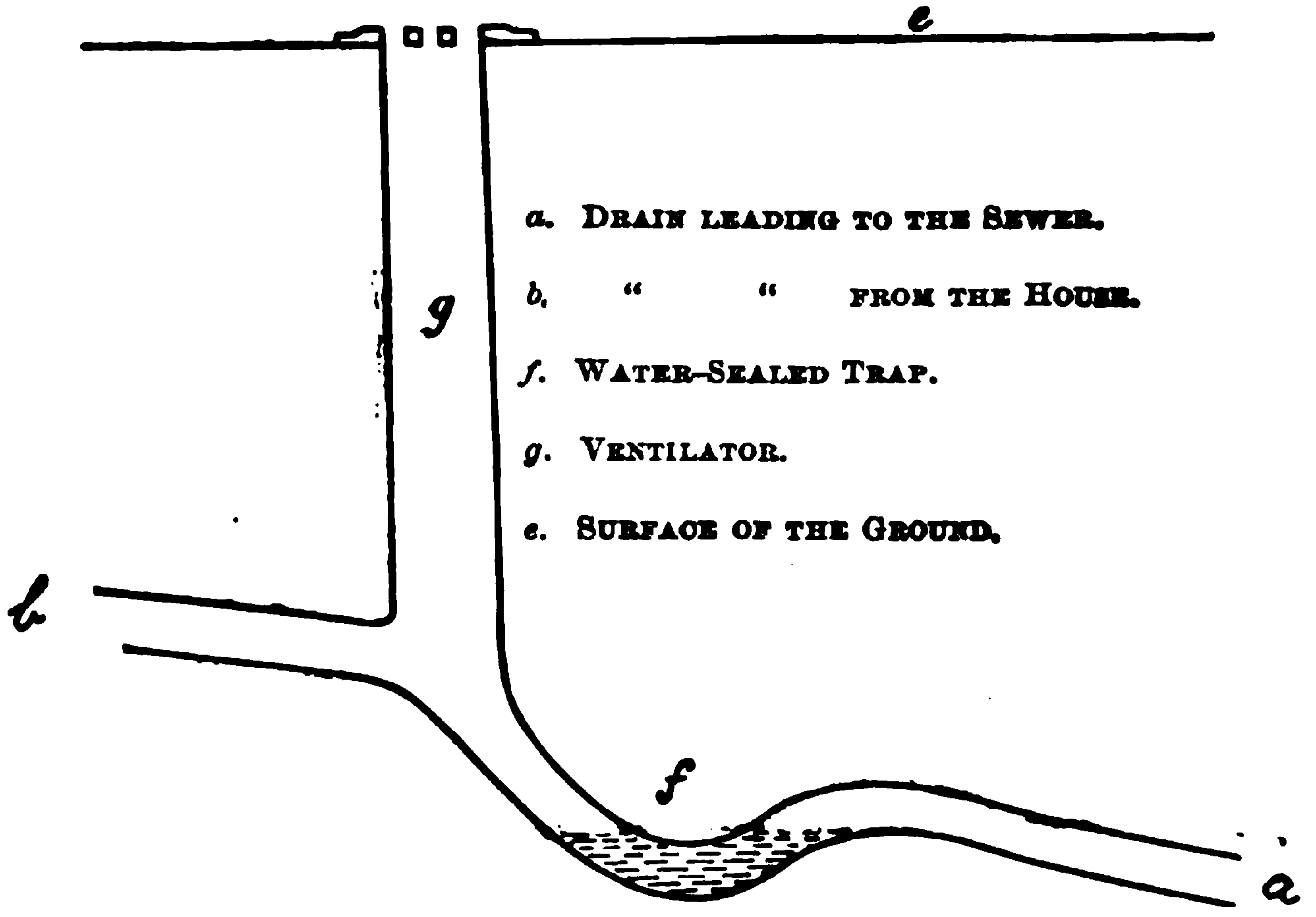
Few sewers are so well constructed as not to require to be isolated from houses by traps. An excellent method of securing this result is shown by the cut, Fig. 1. The ventilator *g* may be made of brick and cement as a manhole, with arrangements for packing, to prevent freezing in winter, and excellent traps are in the market, in one piece, to be used in that case; or it may be continued to the roof by a pipe, which should be used only when there is a trap between it and the sewer. The current of air will usually be found downward, and then upward, and out through the soil-pipe. If extended to the roof, it should not have its upper extremity near a window, or close to a chimney. If used also as a rain-water spout,—a plan which has its advantages for flushing the drains

[1] It occasionally happens that a defect in a drain communicates with the air-supply to a furnace, and so is the means of distributing foul air over the house. Of course the two should never be so near together that such an accident can be possible.

occasionally, — it would be well to have another vent from the drain to allow the escape of compressed air, *provided* the soil-pipe and rain-water spout are ever used for discharging water at the same time.

The best arrangement of the soil-pipe is to carry it up through the roof. In houses already fitted with pan-closets, and not more than two to each soil-pipe, sufficient ventilation may often be got by a pipe at least two inches in diameter, the top of which should not be near and at the level of windows or chimneys. A soil-pipe may be well ventilated, too, by a pipe passing into a *constantly heated* chimney, provided it be so arranged as not to conduct "sewer-gases" into any other part of the house, either by down-draughts through other flues, fire-places, etc., or by insecure joints, and contraction and expansion of the pipe from changes of temperature. If there are several points of discharge into a single soil-pipe, there should be a long vent-pipe similar to that described on p. 453 of the seventh Report of the Board, or a vent into the external air from each, to prevent "siphoning out" of traps.

FIG. 1.



Water-closets, sinks, basins, and bath-tubs should be so securely trapped as to prevent the admission of foul air. Generally speaking, water-closets should be ventilated by direct communication with the external air, and they should never be in sleeping-rooms. A ventilator directly under the seat of the water-closet, and passing with the precautions already given, into a chimney, serves a very good purpose in old houses, when the arrangements cannot be made to fulfil the best requirements, or wherever a constant draught of air can be maintained through the closet-door and out through the ventilator. It is well not to place water-closets in cellars.

Of the various patterns of water-closets in use, the smoothest, the simplest, and those easiest to keep *clean*, *well trapped*, *fully ventilated*, and

thoroughly flushed, are the best.[1] Many are now in use which do not fulfil these indications, but there are others in which the faults of the pan-closet and of the old ill-flushed hopper-closet are corrected: whichever are used, the bowls should be often washed with soap and water.

Wash-basins should not be in sleeping-rooms, unless protected by *efficient* traps; and even then it is safer to guard against a possible accident, and have them in an adjoining room.

In view of the fact that many cities have appointed boards of health by virtue of the authority conferred upon them by chap. 133 of the Acts of the General Court of 1877, the Board desire to call their attention to the following important section of that Act: —

"SECTION 5. *Said boards of health, and the board of health of the city of Boston, in addition to the powers conferred upon them by existing statutes, are hereby authorized to prepare and enforce, in their respective cities, such regulations as they may deem necessary for the safety and health of the people, with reference to house-drainage, and its connection with public sewers, where such connection is made.*"

Gross defects in house-drainage may be detected, and minor defects may be commonly found, by dropping a half-ounce of oil of peppermint into the soil-pipe at its opening above the roof, or through the topmost sink or water-closet in the house; a few quarts of water — better hot — should be poured down after it. If *another* person than the one who has used the peppermint visits the various rooms, cellar, closets, etc., there generally will be no difficulty in ascertaining where a leak may be. A better method still, but very costly, is to use hydrostatic pressure, as is the custom in testing gas-pipes. In any case, the opinion of an inspector or person familiar with the matter is desirable.

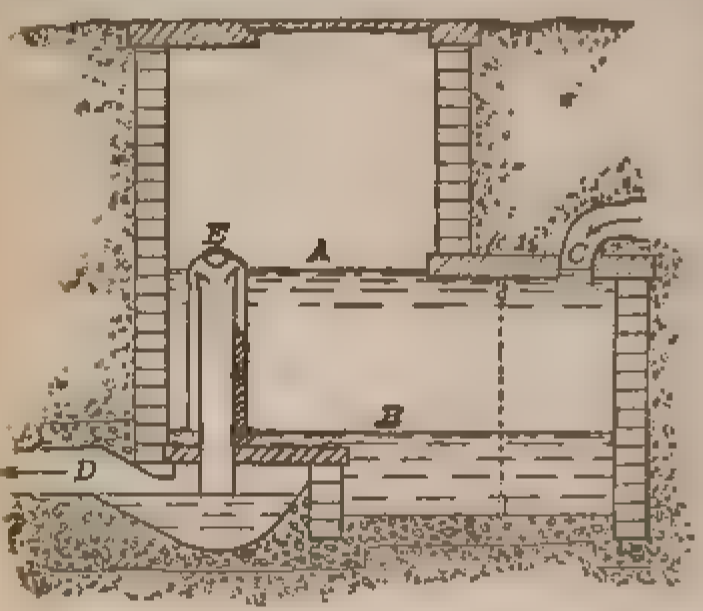
When houses are left vacant for a time, the traps are apt to become dry, — an evil which should be avoided, so far as is possible, by flushing them from time to time, and always a few days before re-occupation of the house; and this flushing of the traps should be supplemented by free ventilation with open windows.

Where water-closets are used, and there are no sewers, the best disposal of the sewage is by the flush-tank and irrigation under the surface of the soil, as described on p. 334 of the seventh, p. 135 of the eighth, and p. 11 of the ninth, annual Report of the Board. (See Fig, 2.[2]) If cesspools

[1] Directions with reference to these points may be had on application to the sanitary engineers intrusted with the drainage of houses; as it is not the purpose of the Board to enter into details, but to insure proper care and forethought in matters so vital to the health of the community.

[2] Reprinted, by kind permission of Messrs. Harper & Brothers, from an article in the June number of the "New Monthly Magazine," by Col. G. E. Waring, jun., who has also drained the town of Lenox on this principle. "A is the surface of the water when the tank is full, and B when it is emptied. The capacity of the tank between the lines A and B is about five barrels. In front of the entrance there is a wire screen to prevent the passage of coarse material. This is held in place by wooden wedges, and may easily be removed for cleansing. The depression below the line B is for the accumulation of solid matters which may not become decomposed. A portion of the tank is carried up to the surface of the ground, with a movable cover for a man-hole. E is Field's automatic annular siphon, by which the tank is emptied as soon as its

must be used, they should be tight, and often emptied by the odorless process, or else have their contents pumped out on the surface of the ground for fertilizing purposes, where that can be done without causing a nuisance. If the sewage is placed on the soil in the morning of a dry, clear day, when the sun is shining, and in places where it may be readily absorbed by the earth, the odors from it are the least offensive. In very loose soil, and remote from dwellings, ordinary loose-walled cesspools may be used without danger for a time; but the custom cannot often be entirely approved. An overflow into a stream or upon the land from a tight-walled cesspool often creates a nuisance, — a difficulty which has been simply and successfully provided for by means of sub-surface irrigation through porous drainage-pipes from the top of the cesspool, laid in the same general way as for use with the flush-tank.



Sewers are of the first importance for removal of sewage, where the water-carriage system is adopted. When for any reason they cannot be introduced, the greatest consideration should be used before it is decided to introduce water-closets, if the result must be to drench the soil with filth and water by means of loose-walled cesspools. The water-carriage system, however, in the opinion of the Board, *if sewers and house-drainage are planned and constructed as they should be*, is by far the most satisfactory, both from a sanitary point of view and as a civilizing agent; and, even where the sewers are very defective, the house-drains may often be so isolated from them by traps and good ventilation as to make the evils of water-carriage less than those of any other system, provided there is an abundant water-supply.

In some cases, where the soil has been polluted so as to endanger the wells, and a public water-supply is not practicable, rain-water may be stored for use; but it should be filtered, and kept free from contamination by dust, dirt, drainage, etc. The water first coming down in rain col-

contents rise high enough to flow over the top of its inner (and longer) limb. The short limb is a dome enclosing the inner limb, with a water-way all around its bottom, reaching to the line B. The drainage flows into the flush-tank, where it is held until the top of the siphon is reached. The whole amount (five barrels) is then discharged with great rapidity into the main sewer (D), washing it clean from end to end. The flow of sewage alone is sufficient to remove all accumulations from the sewer." See also pp. 285–296, 482, 483, and 522, of the *second edition* of Mr. Baldwin Latham's Sanitary Engineering.

lects impure matter from the atmosphere and from the roofs of houses, and this should be thrown away. The rest may be filtered through a brick wall renewed every three months, or by means of animal charcoal, quartz-sand, spongy iron, sponge, cotton-flannel, etc., *frequently cleaned*, although no one of these methods is so good as filtration through clean, well aërated soil. [See "Household Filtration," in an article by Professor W. Ripley Nichols, in the ninth Report of the Board, pp. 205 *et seq.*]

Where the constant system of supply is so universally used as in this country, cisterns for drinking-water are seldom depended upon, except for rain-water. Any overflow-pipe from them should always be kept from discharging directly or through a rain-water spout into a drain or sewer, because such an arrangement would serve as a means of conducting "sewer-gas" into the cistern; and a trap would not be in such case a sufficient protection.

Important as are the proper construction and maintenance of soil-pipes and drains, their thorough usefulness depends also upon a sewerage system adjusted to the wants of each city and town where water-carriage is adopted. Sewers should always be laid according to a definite plan embracing the whole area to be sewered. They should be skilfully built, smooth inside, in straight lines, suitably ventilated, adapted for ready and thorough inspection, of proper size, shape, grade, etc.; they should be tight, and so constructed as not to allow percolation of filth through their walls into the soil and air, although, of course, they may properly be porous enough to drain the soil of superfluous moisture. *The sewage should start from the houses, and go in a continuous current, without allowing any deposits or stopping, until it reaches its destination before putrefaction has begun.* Details with reference to this matter may be found in the eighth Report of the Board, pp. 139 *et seq.*, in an article by E. S. Chesbrough, C.E.

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, May, 1879.

NOTE. — Copies of this circular may be had upon application to the Secretary of the State Board of Health.

Of the following two circulars, the first was distributed quite widely in those cities which failed to avail themselves of the privileges of the law authorizing the appointment of boards of health; the second was sent to physicians and boards of health throughout the State.

STATE HOUSE, BOSTON, March, 1879.

DEAR SIR, — The State Board of Health desire to respectfully call your attention to the enclosed act with regard to boards of health, hoping that you will have the kindness to call attention to its very important provisions so far as you may be able to do so. The Board cannot better express their own views of the great value to every com-

munity of an efficient local health department than by quoting as follows from the inaugural address of the Mayor of Somerville:—

"As I took occasion a year ago to express the opinion that the city had made a mistake in voting to accept the health act passed by the General Court in 1877, I desire now to say that the experience of the past year has led me to an entirely different opinion from the one then expressed. The Board of Health has been in successful operation since its organization in the early part of the year; and, beside relieving the city council of a large amount of work, I am satisfied it has accomplished more in the way of abating a large number of nuisances than it would have been possible to accomplish under the old law. It has also commenced a systematic examination of the house-drainage throughout the city, and to enforce wholesome rules and regulations in all cases of contagious diseases. Without attempting to assign the cause, it is a matter of congratulation that during the last three years the death-rate among us has been gradually diminishing. The following is the number of deaths in our city since its organization:—

		Rate per 1,000.
1872	400	24.30
1873	425	21.70
1874	490	22.96
1875	501	22.86
1876	444	20.18
1877	441	19.15
1878	385	16.21

"As the population of the city is larger than at any previous time, it is only reasonable to conclude from the above figures that the great work done in previous years in abating nuisances that had long been the cause of an unenvied notoriety to our city, and the greater care exercised during the past year, have been among the causes that have contributed to this happy result. Somerville now ranks, if not the first, among the first of the cities of the Commonwealth in point of healthfulness. The rate is lower than the lowest given in the Report of the State Board of Health for 1877."

In behalf of the State Board of Health,

Very respectfully yours,

CHAS. F. FOLSOM, M.D.,

Secretary.

An Act relating to Boards of Health in the Several Cities of the Commonwealth.

Be it enacted, etc., as follows:—

SECTION 1. It shall be the duty of the mayor and aldermen in each of the cities of the Commonwealth, which have not already voted to accept chapter one hundred and thirty-three [1] of the acts of the year eighteen hundred and seventy-seven, to notify and warn the legal voters of said cities to vote upon the acceptance of said act at the then next meeting in said cities respectively, for the election of city officers; *provided* the mayor and aldermen have been requested in writing so to do, thirty days prior to the time of holding said meeting, by fifty voters residing therein.

[1] Authorizing the appointment of boards of health in the cities of the Commonwealth.

Sect. 2. In case of a severe epidemic or of danger to the public health, the mayor and aldermen of any city in the Commonwealth, where there is no board of health, may appoint such a board in accordance with the provisions of chapter one hundred and thirty-three of the acts of the year eighteen hundred and seventy-seven; *provided* they have been requested to do so by one hundred voters in said city.

Sect. 3. This act shall take effect upon its passage.

Approved March 13, 1879.

Office of the State Board of Health,
State House, Boston, June, 1879.

Dear Sir, — The State Board of Health desire to very respectfully call to your notice the fact that they have been requested this year, for the first time, to edit the registration reports of the State; and they beg to earnestly ask for your co-operation in securing the enforcement of the law with reference to the collection of vital statistics, as the importance of the matter will readily occur to you.

All the necessary blanks and information in detail, including the Statistical Nosology, prepared for the International Congress by Dr. William Farr, will be furnished by the Secretary of the Commonwealth, either directly, upon application to him, or through the town or city clerk or local registrar.

Local boards of health are reminded that they can be of very great assistance in this matter, and that the registration can be made very much more accurate than at present by their means.

Any practising member of any branch of the medical profession, who may have attended a person during his last illness, is bound — if applied to within fifteen days after the decease of such person — *forthwith* to "furnish for registration a *certificate* of the duration of the last sickness, the disease of which the person died, and the date of the decease, as nearly as he can state the same." *Penalty for non-compliance,* — ten dollars.

No undertaker or sexton or other person is allowed to bury any body, or to remove it from one town to another for burial, without a permit to do so from the town or city clerk or local registrar; and this permit must not be given until the undertaker or person performing the burial or removing the body has obtained from the physician attending, or from the board of health, or from the physician acting for the board of health, a certificate giving the cause of death, as required by statute. Local boards of health can make arrangements to have these certificates of the causes of death approved by themselves.

In order to facilitate the effective operation of the law, it is earnestly recommended that the medical practitioner who has been in attendance at the death, or during the last illness, of any person, shall *place his certificate of the cause of death, immediately*[1] *after such death, in the hands of some person in attendance, or of some member of the household in which the*

[1] Allowing reasonable time, of course, for cases where there are to be autopsies.

death occurred, for the use of the undertaker or other informant in making return of the death to the town clerk or registrar.

Physicians and local boards of health are respectfully desired to observe the provision in our laws *with regard to births*, and to further in every way in their power the collection of accurate statistics of them. This they can do by themselves sending notice of births; by telling families of their patients what a duty they have to perform; and by showing how important it is that the statistics should be returned *promptly* and *correctly*.

Parents are required by the law to give notice to the clerk of the births of their children; householders, to give notice of every birth happening in their houses; masters of ships, keepers of workhouses, houses of correction, prisons, hospitals, almshouses, — except the three State almshouses, — to give like notice of every birth happening among the persons under their respective charges, *under penalty of a sum not exceeding five dollars* for neglect to give such notice for the space of six months after each event. Parents and other relatives of children born, and the occupiers of tenements in which any births may take place, are requested to report to the clerk or registrar, *as soon after the event as may be, every case of birth* which may occur, including *all still births*.

In behalf of the State Board of Health,

Very respectfully yours,

CHARLES F. FOLSOM, M.D.,
Secretary.

As a result of facts mentioned in the circular on House-Drainage, the local Board of Health of Edgartown have undertaken an investigation with regard to their water-supply and drainage. The State Board have found it necessary to condemn four of the wells in that town as containing an amount of human excrement rendering them dangerous to the public health; and the local board have enforced their order. It has seemed fair to attribute a considerable amount of illness to the use of water from two of the wells; a third was used for a bakery, and the fourth for many transient boarders: so that it is impossible to say how far they may or may not have distributed the seeds of disease. The investigation is still going on under the direction of the Board; and it may prove necessary to condemn other wells, in order to give full security to the thousands of visitors to the town. The local board have issued stringent regulations to prevent an accumulation of filth, which in former years has been excessive, and a source of stenches.

Each year the work of the Board has increased very much in conferring with local boards as to their powers under the

law, and in giving advice with regard to individual complaints, or sources of foul odors and ill health. As more and more towns organize boards of health, there would naturally be more of such work to be done. Indeed, the Board, in the ten years of their existence, have as yet hardly been able to more than prepare the community to see the necessity of concerted action to prevent disease; and, in some form or other, that work must go on.

The establishment of the National Board of Health, their conference with official delegates of the various state boards of health at a meeting called for that purpose in Atlanta, and the successful organization of the Sanitary Council of the Mississippi Valley, composed of the state and municipal boards of health of that valley, for the purpose of preventing the inroad of dangerous diseases, mark a progress in the estimation of the nation of wise measures to prevent disease, and are most encouraging signs for the future.

The correspondence of the Board, and their exchanges of sanitary publications with other boards, in this country and in Europe, have increased very much, so as to place them now in relations with a large part of both countries. Indeed, the library collected, partly in this way, and partly by purchase,—embracing, too, many volumes of letters from sanitarians and others,—is often consulted for the benefit of physicians and boards of health. It has proved of increasing usefulness each successive year.

The following list comprises the subjects upon which special investigations and reports have been made, the results of which were published in the series of reports:—

SLAUGHTER-HOUSES, ETC.

First Report.—Slaughtering for the Boston Market. By Dr. George Derby, Secretary.

Third Report.—Slaughtering, Bone-Boiling, and Fat Melting. By Dr. George Derby, Secretary.

Fourth Report.—Report of the Butchers' Slaughtering and Melting Association. By J. N. Merriam, President.

Fifth Report.—The Brighton Abattoir. Report of the President. Description of the Abattoir. Letter from Mr. J. S. Schultz, describing European Abattoirs in 1873.

Sixth Report. — Our Meat-Supply and Public Health. By Dr. C. F. Folsom, Secretary. The Transportation of Live-Stock. By J. C. Hoadley, Member of the Board. The Brighton Abattoir. By J. N. Merriam, President.

Tenth Report. — "The City of Cambridge v. Niles Brothers." Report of the Evidence taken before the State Board of Health.

PUBLIC HEALTH, ETC.

First Report. — Report on the Sale of Poisons. By the Board. The Prevention of Disease. By Dr. George Derby, Secretary.

Second Report. — Poisoning by Lead Pipe. By Dr. George Derby, Secretary, and Professor W. R. Nichols. Health of Minors employed in Factories. By Dr. George Derby, Secretary, and Dr. F. W. Draper. Ventilation of Schoolhouses. By A. C. Martin, Architect. Air and Some of its Impurities. By Dr. George Derby, Secretary, and Messrs. A. H. Pearson, H. B. Hill, and C. Stodder. The Use and Abuse of Intoxicating Liquors: Correspondence. Houses for the People. Convalescent Homes and the Sewage Question. By Dr. H. I. Bowditch, Chairman of the Board.

Third Report. — Arsenic in Certain Green Colors. By Dr. F. W. Draper. The Effects on Health of the Use of Sewing-Machines moved by Foot-Power. By Dr. A. H. Nichols. The Use and Abuse of Intoxicating Liquors: Analysis of the Correspondence. By Dr. H. I. Bowditch, Chairman of the Board. The Use and Abuse of Opium. By Dr. F. E. Oliver. Mill-Dams and Other Water Obstructions: Effect on Health. By Dr. George Derby, Secretary.

Fourth Report. — Infant Mortality. By Dr. E. Jarvis. Some of the Causes or Antecedents of Consumption: Analysis of a Correspondence. By Dr. H. I. Bowditch, Chairman of the Board. The Homes for the Poor in our Cities. By Dr. F. W. Draper. Beer-Shops and Prohibitory Laws. By P. E. Aldrich, Member of the Board.

Fifth Report. — On the Use of Zinced or Galvanized Iron for the Storage or Conveyance of Drinking-Water. By Dr. W. E. Boardman. Hospitals. By Dr. George Derby, Secretary. School Hygiene. By Dr. F. Winsor. The Work of Local Boards of Health. By Dr. A. Ames, jun. Preventive Medicine and the Physician of the Future. By Dr. H. I. Bowditch, Chairman of the Board. Political Economy of Health. By Dr. E. Jarvis. The Health of the Farmers of Massachusetts. By Dr. J. F. A. Adams. Some Farm-Houses, and some Mistaken Ways of living in them. By Mrs. T. F. Plunkett.

Sixth Report. — Cremation and Burial: An Examination of their Relative Advantages. By Dr. J. F. A. Adams. The Value of Health to the State. By Dr. W. E. Boardman. Inebriate Asylums or Hospitals. By Dr. H. I. Bowditch, Chairman of the Board. Ventilation of Railroad-Cars. By Dr. T. W. Fisher: With Chemical Analyses of the Air in Cars. By Professor W. R. Nichols. Composition of the Air of the Ground Atmosphere. By Professor W. R. Nichols.

Seventh Report. — Registration of Prevalent Diseases. By Dr. F. W. Draper. Sanitary Hints. By Dr. H. I. Bowditch, Chairman of the Board.

Eighth Report. — The Growth of Children. By Professor H. P. Bowditch. Registration of Deaths and of Diseases. By Dr. C. F. Folsom, Secretary.

Ninth Report. — Sanitation of Public Schools in Massachusetts. By Dr. D. F. Lincoln. Dangers from Color-Blindness. By Dr. B. Joy Jeffries. Cottage Hospitals. By Dr. J. F. A. Adams.

Tenth Report. — Physical Education in Amherst College. By Professor E. Hitchcock, M.D. The Growth of Children. By Professor H. P. Bowditch. Coal-Gas from Heating-Apparatus. By Dr. F. Winsor. A Contribution to the Study of Ventilation. By Dr. E. Cowles.

DISEASES AND THEIR PREVENTION.

Second Report. — Health of Towns.

Third Report. — Health of Towns.

Fourth Report. — Health of Towns.

Fifth Report. — Health of Towns.

Sixth Report. — Health of Towns.

Seventh Report. — Health of Towns.

Eighth Report. — Health of Towns.

Ninth Report. — Health of Towns.

Tenth Report. — Health of Towns, Boards of Health, Water-Supplies, Prevalent Diseases, Circular on Drainage, etc.

Second Report. — Mortality of Boston in 1870. By Dr. George Derby, Secretary, assisted by Dr. F. W. Draper. Trichiniasis in Massachusetts. By Dr. George Derby, Secretary. Charbon, or Malignant Pustule, in Massachusetts. By Dr. A. H. Nichols. Typhoid Fever in Massachusetts. By Dr. George Derby, Secretary.

Third Report. — Small-Pox in Massachusetts. By Dr. George Derby, Secretary.

Fifth Report. — Typhoid Fever in Medford in 1873. By Dr. A. H. Nichols. The Epidemic of Cerebro-Spinal Meningitis in Massachusetts in 1873. By Dr. J. B. Upham. Small-Pox in Spencer in 1873. By Dr. F. W. Draper.

Sixth Report. — Report on the Sanitary Condition of the State Prison at Charlestown. By the Board.

Seventh Report. — Health of Boston in 1875. By Dr. F. E. Oliver. Health of Lowell in 1875. By Dr. F. Nickerson. Report on an Outbreak of Intestinal Disorder, attributable to the Contamination of Drinking-Water by Means of Impure Ice (Rye Beach, N.H.). By Dr. A. H. Nichols.

Eighth Report. — The Sanitary Condition of Lynn. By Dr. J. G. Pinkham. Diphtheria in Lynn. By Dr. J. G. Pinkham. Diphtheria in Salem. By Dr. A. H. Johnson. Diphtheria in Lowell. By Dr. F. Nickerson.

Ninth Report. — Diphtheria in Gloucester. By Dr. C. F. Folsom, Secretary. Diphtheria in Taunton. By Dr. A. S. Deane. Typhoid Fever in Taunton, Raynham, Saugus. By Dr. C. F. Folsom, Secretary.

The Sanitary Condition of Cambridge. By Dr. E. R. Cogswell. Scarlet Fever. By Dr. A. H. Johnson. Vegetable Parasites, and the Diseases caused by their Growth upon Man. By Dr. J. C. White.

FOOD AND DRINK.

SECOND REPORT. — On the Use of Milk from Cows affected with "Foot-and-Mouth Disease." By Dr. A. H. Nichols.

THIRD REPORT. — The Adulterations and Impurities of Food. By Professor H. B. Hill.

FOURTH REPORT. — Character of Substances used for flavoring Articles of Food and Drink. By Dr. H. K. Oliver. The Food of the People of Massachusetts. By Dr. George Derby, Secretary. The Adulteration of Milk. By Dr. A. H. Nichols and Professor J. F. Babcock. The Adulterations and Impurities of Food. By Professor H. B. Hill.

NINTH REPORT. — The Filtration of Potable Water. By Professor W. R. Nichols.

INSANITY, AND PROVISION FOR THE INSANE.

THIRD REPORT. — Proper Provision for the Insane. By Dr. E. Jarvis.

EIGHTH REPORT. — Disease of the Mind. By Dr. C. F. Folsom, Secretary.

TENTH REPORT. — Hospital Homes for the Insane. By Dr. T. S. Clouston.

DRAINAGE, SEWERAGE, POLLUTION OF STREAMS, ETC.

SECOND REPORT. — Pollution of Mystic-Pond Water. By Dr. George Derby, Secretary, and Professor W. R. Nichols.

FOURTH REPORT. — Sewerage; Sewage; the Pollution of Streams; the Water-Supply of Towns. By Dr. George Derby, Secretary, and Professor W. R. Nichols. Drainage for Health. By H. F. French.

FIFTH REPORT. — On the Present Condition of Certain Rivers of Massachusetts, together with Considerations touching the Water-Supply of Towns. By Professor W. R. Nichols.

SEVENTH REPORT. — A Special Report on (1) The Pollution of Rivers; an Examination of the Water-Basins of the Blackstone, Charles, Taunton, Neponset, and Chicopee Rivers, with General Observations on Water-Supplies and Sewerage. By J. P. Kirkwood, C.E. With an Appendix giving Chemical Analyses. By Professor W. R. Nichols. (2) The Water-Supply, Drainage, and Sewerage of the State from the Sanitary Point of View. By Dr. F. Winsor. (3) The Disposal of Sewage. By Dr. C. F. Folsom, Secretary. (4) Summary and Recommendations. By the Board. Surface-Drainage of the Metropolitan District. By C. W. Folsom, C.E. Defects in House-Drainage, and their Remedies. By E. S. Philbrick, C.E.

EIGHTH REPORT. — Sewerage: its Advantages and Disadvantages, Construction and Maintenance. By E. S. Chesbrough, C.E. The Pollution of Streams; Disposal of Sewage, etc. By Dr. C. F. Folsom,

Secretary: With Chemical Examinations. By Professor W. R. Nichols: and a Map of the Nashua-River Basin. By E. K. Clark, C.E.

NINTH REPORT. — Drainage and Health: Sewerage and the Pollution of Streams; including the Draught of a Law. By the Board.

TENTH REPORT. — Common Defects in House-Drains. By E. C. Clarke, C.E.

These matters were treated of, also, at greater or less length by the Board, in their general reports for the several years, where they have also considered the following subjects: —

MODEL LODGING-HOUSES AND TENEMENT-HOUSES.

FIRST REPORT. — Comparison of their Relative Effects upon the Health and Morals of the People.

SECOND REPORT. — Overcrowding of Tenement Houses, and Want of Clean Streets in Boston.

THIRD REPORT. — Model Lodging and Low Tenement Houses.

INTOXICATING LIQUORS.

FIRST REPORT. — Their Use as a Beverage.

TENTH REPORT. — Intemperance.

SLAUGHTER-HOUSES, ETC.

THIRD REPORT. — Law concerning Slaughter-Houses and Noxious and Offensive Trades: Doings of the Board under said Law.

FOURTH REPORT. — The Same

FIFTH REPORT. — The Same.

SIXTH REPORT. — The Same.

SEVENTH REPORT. — The Same.

EIGHTH REPORT. — The Same.

NINTH REPORT. — The Same.

TENTH REPORT. — The Same.

THIRD REPORT. — The Brighton Butchers and the Proposed Abattoir.

FOURTH REPORT. — Butchers' Slaughtering and Melting Association.

FIFTH REPORT. — The Brighton Abattoir.

SIXTH REPORT. — The Brighton Abattoir.

SEVENTH REPORT. — The Abattoir and the Slaughter-Houses in Brighton.

DRAINAGE, SEWERAGE, SEWAGE, ETC.

SECOND REPORT. — Pollution of Streams.

FOURTH REPORT. — Miller's-River Commission; Sewerage of the Metropolitan District.

FIFTH REPORT. — Sewerage of the Metropolitan District; Miller's-River District in Cambridge and Somerville.

Sixth Report. — Drains and Sewers.

Eighth Report. — Pollution of Streams; Disposal of Sewage, etc.

Ninth Report. — Drainage and Sewerage; Sewage of Concord State Prison; Pollution of Streams; Summary of Bill; Pollution of Streams.

Tenth Report. — The Disposal of Sewage; Sewerage of the Worcester Lunatic Hospital; Danvers Lunatic Asylum; Concord State Prison, and the Women's Prison at Sherborn.

PUBLIC HEALTH.

First Report. — The Condition of "Lock-ups."

Second Report. — The Foot-and-Mouth Disease in Cattle: its Effects on Man; Small-Pox in Massachusetts; Sewing-Machines: Influence on Health of Female Operatives.

Third Report. — The Influence of Mill-Ponds on Health; Record of Sickness.

Fourth Report. — A Receiving-Tomb in the Vicinity of Houses; Revision and Codification of Health Laws; Boards of Health; Small-Pox.

Fifth Report. — Undrained Land; Excavations in Clay Lands; Asiatic Cholera; Small-Pox.

Sixth Report. — Charcoal Pits; Registration of Disease; Local Boards of Health; Hydrographical Survey; The Sale and Use of Poisons; Investigation of Alleged Sickness from Low Water in "Little Pond."

Eighth Report. — Supervision of the Insane.

Ninth Report. — Boards of Health; Vital Statistics; Circulars on Hydrophobia, Scarlet Fever, and Diphtheria.

Tenth Report. — Yellow Fever in 1878; Poisoning by Arsenic; Boards of Health; Vital Statistics; Supervision of the Insane; Syphilis and Prostitution; The Law appointing Medical Examiners; Regulation of the Practice of Medicine; Impure Ice, not freed from Impurities by Freezing.

Many subjects are still under consideration, upon several of which a considerable amount of work has already been done. Under the new law, the duties of the Health Department will be increased — as was proposed by the Board some time ago — by the sanitary supervision of the public institutions of the State.

The topics which seem to demand the most immediate attention and investigation are, —

A digest of the laws of public health of the State, for the use of local boards of health.

A survey of the river-basins of the State, in continuation of the study of pollution of streams.

An investigation into the question of the relation of privies to wells.

An examination of the Merrimack River and Mystic Pond

as sources of water-supply, and, so far as possible, the sanitary condition of the cities situated upon them.

A concise series of regulations, to be published under the direction of the Board, to be followed out in works of water-supply, house-drainage, sewerage, and disposal of sewage.

The relation of diseases of animals, especially of swine, cows, and horses, to men; the dangers therefrom, and the means of obviating them.

Adulteration of food.

Arsenic.

This list comprises only a small portion of the subjects under consideration, and it is hoped that it will be possible to take up the others in their proper time.

All of which is very respectfully submitted.

HENRY I. BOWDITCH.
ROBERT T. DAVIS.
RICHARD FROTHINGHAM.
DAVID L. WEBSTER.
JOHN C. HOADLEY.
THOMAS B. NEWHALL.
CHARLES F. FOLSOM.

The expenses of the Board for the half year are as follows:—

Printing and stationery	$326	90
Postage and stationery	262	70
Travelling expenses	198	22
Carriage and horse hire	51	50
Messenger	45	25
Books and binding	41	80
Express	15	50
Plans for hospital	15	00
Gas-fixtures	4	42
Repairing curtains	1	00
Ink		50
Expert to visit Weymouth	10	00
T. H. Hay, clerk	275	00
	$1,247	79

GENERAL INDEX.

VOLUMES I.–XI.

BY

FRANCIS H. BROWN, M.D.,

BOSTON.

GENERAL INDEX.

Towns, Health of towns — *Continued.*

Towns, Health of towns — *Continued.*

Towns, Diseases, Diphtheria — *Continued.*

Towns, Diseases, Diphtheria — *Continued.*